THE SECOND ANNUAL AWARD FOR EXCELLENCE IN TEACHING AN ANALYSIS OF PROCEDURE AND DATA

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THESIS

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The Second Annual Award for Excellence in Teaching

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ABSTRACT

The procedure and data of the Second Annual Award for Excellence in Teaching are discussed and studied. Basic statistics of balloting are presented and increased participation is noted. The techniques of data reduction are described. Some special studies are made concerning (i) score data has distribution of mixed exponential type (ii) the effect on the score of whether or not an instructor teaches during the quarter of the balioting (iii) concordance determination with last year's ranking of instructors. Recommendations for modifying future procedural items are made.

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I. INTRODUCTION

The Superintendent of the U. S. Naval Postgraduate School, Rear Admiral Robert W. McNitt, USN, directed in May of 1969, that an award be established to recognize excellence in teaching. To comply with his directives a committee was formed from among the faculty. The objective of this committee was to select a recipient each year for the Outstanding Teaching Award to be given during the June graduation.

This committee was to be composed of a Chairman, a secretary and five members. These seven people were to be chosen to provide a wide variety of backgrounds and curricula. Each year four persons would leave the committee and be replaced by four new members. Thus, new ideas and concepts would be engendered in the selection process while retaining a core of persons familiar with the existing system.

The members of this year's committee were Professors Kovach (Chairman), Hoisington (Vice-Chairman and Secretary), Musgrave, Nunn, Renard, Read and Schultz. The committee decided to retain from last year's committee the same philosophical outlook concerning the nature of excellence in teaching along with how it should be reliably identified and evaluated. The interested reader will find this outlook in Robert William Geary's Thesis, The First Annual Award for Excellence in Teaching, A Study of Procedure and Analysis of Data, June 1970. However, to set the groundwork for this paper certain guidelines for the selection process will be discussed. These guidelines are as follows:

1. All faculty with the exception of the Department Chairmen and the members of the selection committee are eligible to receive the award.

2. The voting population includes all current students, faculty, Curricular Officers and Assistant Curricular Officers. Also included this year is the group of Naval Officers which graduated in 1969.

3. Participation in the poll is entirely voluntary and no one is required to sign his ballot.

4. Care and discretion are to be used to ensure that no ranking of candidates is published.

5. For the ballot to be valid the voter must indicate himself to be reasonably well acquainted with at least five members of the candidate list.

6. The voting population is cautioned not to vote on the basis of personality or popularity but on teaching ability and performance.

In order to maintain total objectivity among the selection committee it was determined that an individual from outside the faculty would handle the ballots, collate the data and submit the results to the selection committee. Only after the recipient of the award had been selected, would the winner's name be made known to the selection committee.

II. THE BALLOT

A. FORMAT

An instruction sheet was attached to the front of the ballot to explain the purpose of the award, give instructions on how to fill out the ballot, and explain the requirements for validating the ballot. Results indicate that greater care should be exercised in preparing the cover sheet, particularly in the area of ballot validity. This is covered in greater length later in this section.

The ballot itself was composed of four parts. Part A was a statistical gathering aid to help in an analysis of the voting population characteristics. The voter was asked to identify his voter category, rank, Branch of Service, and Curricular area if military; if civilian his academic rank and department were to be circled.

Part B included three blanks to be used in indicating first, second, and third choices for the award using the four digit identification number in Part C.

Part C of the ballot identified the candidates for the voter. Each eligible faculty member was listed in alphabetical order under the heading of his department. A four digit identification number preceded each candidate. The voter was asked to circle this identification number of all those faculty members with whom he considered himself to be reasonably well acquainted in an academic capacity.

The last portion of the ballot, Part D, was to be used to comment on the reasons for his selection. This portion was not mandatory, but was considered beneficial in the final selection processes.

The major variations in this year's ballot from the year before were as follows:

1. The second portion of the ballot (the blanks) was added to provide a faster and safer means of extracting the nominations from the ballot.

2. The blanks were removed from the left side of the four-digit identification number.

The only changes recommended for the actual ballot for next year would be to include another blank in Part B that can be marked with a "1" if a comment is made in Part D and to assign each teacher a permanent four digit identification number for Part C instead of renumbering each year. This would further facilitate data retrieval. Included as Annex A of this document is a FY '71 ballot.

B. THE BALLOTING PROCESS

The method whereby the ballots were distributed and returned merits attention, for the selection process is only as good as the response of the voters.

Last year the ballots were distributed through the Curricular Officers and Section Leaders. In an attempt to increase student participation the selection committee decided a new method should be found for distributing and returning the ballots. The ballots were distributed utilizing the Student Mail Center (SMC) this year. The completed ballot was placed in an envelope addressed to the Superintendent of the Naval Postgraduate School and deposited in a marked box outside the SMC. The envelopes were coded 55 BAL to help route them to the person assembling the data.

The Alumni selected to participate were the Naval Officers who graduated in calendar year '69. Their names and addresses were taken from a data tape maintained in the computer facility after the addresses had been updated [ref. 4]. The completed ballots were returned to the mailing address previously mentioned.

C. BALLOT VALIDATION

1. Assembling the Data

Once the completed ballots had been returned to a central location, the validation process for each ballot began. The ballots were removed from their envelopes and cover sheets were discarded.

The validation process encompassed counting to ensure that Part C of the ballot had at least five identification numbers circled and that Part B did not have any write-in nominations. If less than five identification numbers were circled in

Part C or if the only nominations were write-ins, the ballot was considered void and placed in a separate stack. Valid ballots were numbered so that specific data could be retrieved at a later date if necessary.

The chief cause of void ballots was the restriction that at least five persons be known by the voter. Of the 281 void ballots, 265 were deemed void for this reason.

Another fifteen ballots or 5.7% of all void ballots were deemed void because write-in nominations of ineligible faculty had been made in place of numbers from the eligible faculty.

One reason for the high number of void ballots, 281 out of 1722, could be attributed in part to the influx of first quarter students. Each person receiving a ballot was requested to return the ballot whether or not he knew five eligible faculty members. Yet, the number of void ballots is too great to be the result of first quarter students alone. Therefore, it was concluded that a large number of persons misinterpreted the instructions.

2. Transfering the Data to Tape

When the above validation process was completed, the ballots were given to key punch operators to transfer the data to IBM cards. The IBM cards were used as data for a COBOL routine to check for key punch errors and transfer virtually error free data to a magnetic tape.

An explanation of how the COBOL routine checked for key punch errors will also clarify why the identification numbers were used. The four digits comprising the teacher identification number were arranged so that the first three digits identified the particular teacher. The first teacher on the ballot had an identification number 101. One was added to this number to form the identification number for the second teacher, 102. The process was repeated until the last identification number was formed. The first three numbers formed a vector, $\overline{N}$, which when multiplied by a fixed weighting vector, $\overline{S}$, formed an inner product. The last digit of this inner product

formed the fourth digit of the identification number. As an example teacher 299 would yield

$$(299)\begin{pmatrix}3\\5\\1\end{pmatrix} = 6 + 45 + 9 = 6\underline{0}.$$

Thus, his full number would be 2990.

The above described procedure proved very useful for only correct identification numbers were transferred from the ballot to the tape. An error in key punching would cause an error message giving the ballot number and its cause for rejection.

III. STATISTICAL ANALYSES

A. POPULATION CHARACTERISTICS

One of the most important factors of the voting was the voter response. After sorting the valid from void ballots the percentages of response were determined for each voter cagegory. Table I below lists findings from the breakdown of the ballots.

Table I. BALLOT BREAKDOWN

Voter Category	No. Eligible Voters	No. Valid Ballots	% Valid From Eligible	% Increase Over Previous Year
Student	1890	1023	54.1	5.1
Alumni	525	246	46.9	7.9
Faculty	314	107	34.1	8.5
Curricular Officer	16	5	31.3	(1.7)
Unknown*	—	60		

* Includes 40 ballots in which Part A was omitted
() Indicates negative number

The last column of Table I presents the percentage change over the last year, indicating that all valid voter categories, except that of the Curricular Officers[1], improved. The number of eligible voters in both the student and faculty categories increased appreciably; therefore, the percentage increases shown indicate a significant increase in response.

This year before mailing the alumni ballots, the address tape maintained by the computer center was updated. Even though five less ballots were mailed the increase in response was 7.9 percent. This supports the belief that updating of the tapes would improve alumni response.

The large number of ballots with no voter category indicated this to be a definite problem area. Two possible causes are listed on the following page:

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[1] Curricular Officers who identified themselves as alumni had their ballots included in the alumni group.

1. The instructions concerning the voter category were vague and misinterpreted.

2. The voter did not want to take the time to fill out Part A.

3. The voter did not want to be identified.

Of the above the most likely explanation concerns the instruction sheet. The reference to Part A was given under Step O. This may have led the voter to assume that no importance was placed on this information. However, in order to improve the balloting procedure, information concerning the voters is necessary. The format of Part A should be changed to place the voter category under the heading of VOTER CATEGORY instead of beside the heading in hopes that the voters' attention will be called to the choices.

The 1441 valid ballots consisted of 71 percent students, 17.1 percent alumni, 7.4 percent faculty, 0.3 percent Curricular Officers and 4.2 percent unknown. The 420 ballot increase over last year reflects both an increase in voter population and improved participation in the voting.

B. CLOSER OBSERVATIONS

After studying the voter categories it was determined to research the military and faculty data for further information concerning the voter population. Table II presents a breakdown of faculty voters by curricular department and academic rank. The columns indicate the different ranks and rows indicate academic department. By scanning the j^{th} column and i^{th} row, a determination of the number of valid ballots from faculty of i department and of j rank can be made.

Tables III, IV and V breakdown the military voters by Branch of Service, Rank and Voter Category respectively in each curricular area. The i^{th} row gives the curricular area and the j^{th} column gives Branch of Service, Rank, or Voter Category according to the title of the table. The "faculty" column in Table V, Voter Category, contains those ballots marked faculty and military. One possible explanation for a person being listed as military and a member of the faculty would be that the voter

Table II. FACULTY

Rank / Department	Instructor	Assistant Professor	Associate Professor	Professor	Total Voted	Number Enrolled
Aeronautics			4	3	7	22
Aviation Safety	1	1			2	5
Business Administration & Economics	5	2	2	4	13	31
Electronics Engineering		3	8	5	16	45
Government & Humanities	1		3	1	5	11
Material Science & Chemistry			2	3	5	13
Math	3	2	4	2	11	40
Mechanical Engineering		2	2	3	7	15
Meteorology		3	2	2	7	15
Oceanography	1	1	1	3	6	15
Operations Analysis	2	1	8	1	12	46
Physics	1	2	2	8	13	35
Navy Management Systems Center			1	2	3	21

Table III. BRANCH OF SERVICE

CURRICULAR AREA	NAVY	ARMY	MARINE	COAST GUARD	AIR FORCE	FOREIGN
No Curriculum Noted	16		1			1
30 Operations Analysis	123	26	18	1		7
31 Aeronautical Engineering	68		1			1
32 Electronics & Communication	119		1	1		10
33 Ordnance	66	7	2		1	3
34 Naval Engineering	52					2
35 Environmental Science	110					2
36 Management & Computer Science	230		9	16		3
37 Engineering Science	35	1			1	
38 Baccalaureate	134					
39 Defense Management	7			1		4
TOTALS	960	34	32	19	2	33

Table IV. RANK

CURRICULAR AREA	01	02	03	04	05	06
No Curriculum Noted	3	2	10	5	1	1
30 Operations Analysis	29	9	88	63	6	2
31 Aeronautical Engineering	14	2	40	21	4	
32 Electronics & Communication	30	6	69	41	4	3
33 Ordnance	13	9	33	26	4	1
34 Naval Engineering	9	10	31	11		2
35 Environmental Science	20	10	51	39	4	
36 Management & Computer Science	68	12	64	86	62	9
37 Engineering Science	5	1	20	10	2	
38 Baccalaureate	32	1	39	53	37	
39 Defense Management	1			3	4	5
TOTALS	224	62	445	358	128	23

Table V. VOTER CATEGORY

CURRICULAR AREA	No Voter Category	STUDENTS			Faculty	Alumni	Curricular Officers
		Enroll-ment	Votes	Per-centage			
No Curriculum Noted			19		1	5	
30 Operations Analysis		291	182	62.5	1	24	
31 Aeronautical Engineering		209	62	56.9		21	
32 Electronics & Communication		238	134	56.3		20	
33 Ordnance		94	70	74.5	1	21	
34 Naval Engineering		90	48	53.3		17	1
35 Environmental Science		170	97	57.0	3	24	2
36 Management & Computer Science	2	390	227	58.2	3	77	2
37 Engineering Science		115	37	32.2		5	
38 Baccalaureate		307	132	42.9	1	32	
39 Defense Management	1	86	15	17.4			
TOTALS	3	1890	1023	54.1	10	246	5

was one of the school's Navy Instructor personnel. Another possible explanation would be an error in completing Part A of the ballot. However, the first explanation was deemed to be the more probable of the two. Figure 1, Recommended Part A, is a possible solution to some of the previously mentioned problems in this area.

Voter Category

S	Student
F	Faculty
A	Alumnus
C	Curricular Officer

Students, Alumni, Curricular Officers

Rank	Branch of Service		Curricular Area	
01	N	Navy	30	Ops Analysis
02	M	Marine Corps	31	Aero Engr
03	A	Army	32	Elec & Comm Engr
04	C	Coast Guard	33	Ordnance
05	L	Air Force	34	Naval Engr
06	F	Foreign	35	Envir Sci
07			36	Mange & Comptr Sci
			37	Eng Sci
			38	Baccalaureate
			39	Def Management

Faculty

Rank		Department	
IR	Instructor	AE	Aeronautics
AT	Asst Prof	AO	Aviation Safety
AC	Assoc Prof	MN	Bus Ad & Econ
PR	Professor	EE	Elec Engr
		GH	Govt & Humanities
		MC	Mat Sc & Chem
		MA	Math
		ME	Mech Engr
		MR	Meteorology
		OC	Oceanography
		OA	Ops Analysis
		PH	Physics
		NS	Navy Mgt Sys Center

Figure 1. RECOMMENDED PART A

C. DISTRIBUTION OF M_i

An interesting statistic concerning the voting population was the number of eligible faculty members known by the i^{th} voter. As the i^{th} voter becomes acquainted with more faculty, he should be able to choose better for he is more familiar with the teaching methods of the eligible population.

Figure 2 presents a histogram of M_i, the number of eligible faculty members known by the i^{th} voter. The mean or average number of faculty members known by the voting population was 16.8. At first glance this appears to be a good number, then there was the realization that a ballot must have hade at least five eligible faculty

members marked known before it was considered to be valid. This fact along with a standard deviation of 9.7 showed that it was not safe to assume the average voter's choice to be founded on a large base of experience. Until such time as a method can be devised to weight the ballots based on the voter's experience, it should suffice to say that considering the wide range of voter experience (1 to 8 quarters) a large varience, 94.7, in M_i was and can be expected.

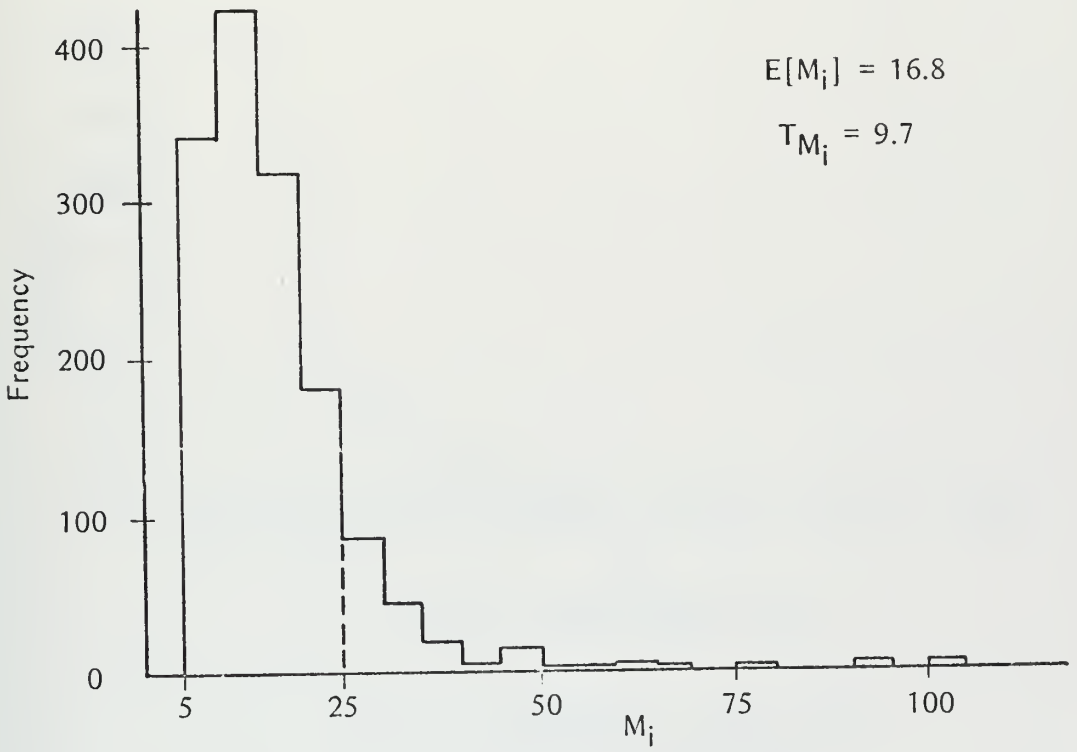

Figure 2. HISTOGRAM OF M_i

D. DISTRIBUTION OF N_k

Now that an indication of how many faculty were known on each ballot has been given, it would prove useful to discuss how many ballots indicated acquaintance with each faculty member. Figure 3 gives a histogram of N_k, the number of voters identifying teacher k. Table VI presents the frequency table used for this discussion. The mean number of voters who know teacher k was 82.9 with a standard deviation of 62.5. Of special interest was the fact that 514 people indicated they knew one teacher. Due to this phenomena the teacher would have had to have significantly

more votes than the others in order to place high in the standings. This pointed out one of the major weaknesses of the present system of selection which is expounded upon in subsection E Determination of S_k.

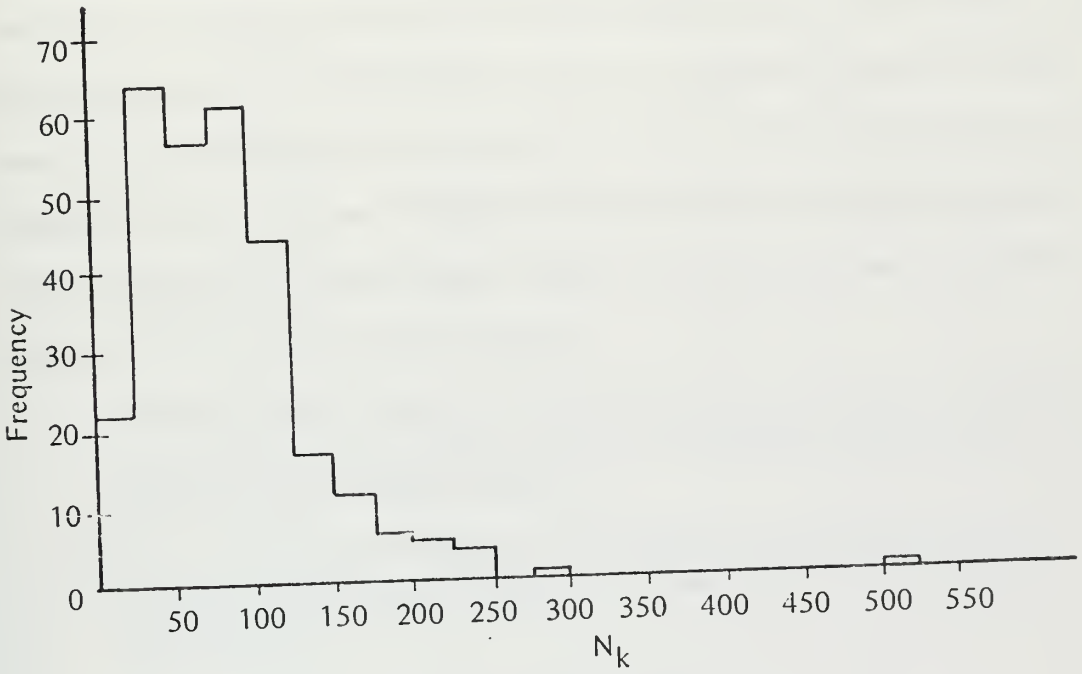

Figure 3. HISTOGRAM OF N_k

Table VI. FREQUENCY TABLE OF N_k

CELL	FREQUENCY
1- 24	22
26- 50	64
51- 75	56
76-100	61
101-125	44
126-150	16
151-175	11
176-200	6
201-225	5
226-250	3
251-275	0
276-300	1
301-325	0
⋮	⋮
501-515	1

E. DETERMINATION OF S_k

After the balloting data had been transfered to magnetic tape, a series of computer programs were run to determine specific statistics from the data. Appendix B contains a listing of these computer programs. One of the first important statistics determined was the score, S_k, of each professor. In order to perform this exercise the data was transferred to magnetic tape by the use of the computer routine "TRANSFER". A second computer routine "PROFSORT" was run to rearrange the data from ballot format to a format identifying each teacher, T_k. That routine also gave a frequency distribution of M_i. After the "PROFSORT" routine had been completed, the third routine, "SCORSORT" was run giving a printout of each teacher and his respective score which had been determined as follows:

1. Teacher k's first, second, and third place votes x_1, x_2 and x_3 respectively were divided by the number of persons identifying teacher k in Part C of the ballot. This yielded a vector V_k.

2. The vector V_k was multiplied by a weighting vector $\overline{W}$ and the product yielded S_k, the score for teacher k. Mathematically this operation was expressed as

$$S_k = V_k \cdot \overline{W}$$

The following table presents a summary of the "SCORSORT" printout showing k, S_k, Z_k, N_k, X_{1k}, X_{2k}, and X_{3k} respectively.

Table VII. SCORSORT SUMMARY

k	S_k	N_k	Z_k	X_{1k}	X_{2k}	X_{3k}
1	2.12121	66	140	26	16	4
2	2.08955	134	280	59	18	8
3	1.84000	25	46	8	6	2
4	1.82692	104	190	38	14	10
5	1.77419	31	55	11	5	1
6	1.69474	95	161	29	18	9
7	1.68831	77	130	27	9	4
8	1.63134	217	354	58	47	28
9	1.59420	69	110	20	12	6
10	1.55556	99	154	25	22	10
11	1.53704	54	83	15	8	7

Table VII. SCORSORT SUMMARY (continued)

k	S_k	N_k	Z_k	X_{1k}	X_{2k}	X_{3k}
12	1.50000	44	66	12	5	8
13	1.47312	93	137	27	11	7
14	1.42857	49	70	11	10	6
15	1.41935	93	132	21	19	10
16	1.28571	28	36	6	4	4
17	1.27907	129	165	31	15	11
18	1.27149	221	281	49	31	23
19	1.24528	159	198	30	30	18
20	1.18103	116	137	25	16	5
21	1.09917	121	133	22	12	21
22	1.08929	56	61	12	6	1
23	1.08696	115	125	23	11	11
24	1.08197	61	66	12	6	6
25	1.07200	125	134	20	22	10
26	1.02083	96	98	19	6	10
27	0.99415	171	170	25	25	20
28	0.98718	78	77	14	7	7
29	0.98077	52	51	8	8	3
30	0.95652	46	44	8	5	2
31	0.94737	57	54	10	4	6
32	0.91667	96	88	14	11	10
33	0.91667	24	22	3	4	2
34	0.89011	91	81	14	8	9
35	0.86207	29	25	5	2	1
36	0.82836	134	111	15	19	13
37	0.80488	82	66	8	13	8
38	0.79762	84	67	7	15	9
39	0.78571	28	22	2	4	6
40	0.77193	57	44	9	4	0
41	0.72436	156	113	17	16	13
42	0.70476	105	74	15	6	2
43	0.70000	100	70	12	9	4
44	0.70000	20	14	0	5	4
45	0.68889	45	31	2	10	3
46	0.68889	45	31	4	4	7
47	0.68750	32	22	4	2	2
48	0.68182	110	75	12	9	9
49	0.67568	74	50	3	14	10
50	0.66990	103	69	13	6	5
51	0.66000	50	33	5	5	3
52	0.65049	103	67	9	12	7
53	0.64444	90	58	10	5	8
54	0.63889	36	23	4	3	1
55	0.63415	82	52	9	5	6

Table VII. SCORSORT SUMMARY (Continued)

k	S_k	N_k	Z_k	X_{1k}	X_{2k}	X_{3k}
56	0.62821	78	49	9	2	9
57	0.60938	64	39	8	3	1
58	0.58511	94	55	8	8	7
59	0.57798	109	63	7	12	11
60	0.57463	134	77	16	4	5
61	0.57317	82	47	6	9	5
62	0.57143	77	44	6	8	4
63	0.56522	184	104	14	20	8
64	0.56436	101	57	8	9	7
65	0.56383	94	53	7	7	11
66	0.56250	48	27	5	1	5
67	0.56000	50	28	4	4	4
68	0.55670	97	54	8	3	6
69	0.54369	103	56	10	3	10
70	0.53226	62	33	4	6	5
71	0.51961	102	53	6	13	3
72	0.51948	77	40	6	5	6
73	0.51515	33	17	1	5	3
74	0.51316	76	39	4	9	5
75	0.51304	115	59	8	8	11
76	0.50769	65	33	4	6	5
77	0.50549	91	46	7	6	6
78	0.50000	104	52	9	6	4
79	0.48837	43	21	3	4	1
80	0.48780	82	40	7	3	6
81	0.47500	40	19	2	4	3
82	0.47287	129	61	9	9	7
83	0.47170	53	25	2	6	5
84	0.46087	115	53	8	7	7
85	0.46067	89	41	5	7	7
86	0.45455	44	20	3	3	2
87	0.44828	29	13	2	1	3
88	0.43662	142	62	8	12	6
89	0.42991	107	46	7	7	4
90	0.42391	92	39	5	6	7
91	0.42308	52	22	3	3	4
92	0.41758	91	38	6	4	6
93	0.41045	134	55	5	11	13
94	0.40909	44	18	2	2	6
95	0.40288	139	56	6	11	10
96	0.39286	56	22	4	1	4
97	0.39286	56	22	3	3	4
98	0.39024	41	16	2	3	2

Table VII. SCORSORT SUMMARY (continued)

k	S_k	N_k	Z_k	X_{1k}	X_{2k}	X_{3k}
99	0.38710	124	48	6	8	8
100	0.37975	79	30	3	6	6
101	0.36364	77	28	5	2	4
102	0.36232	69	25	4	2	5
103	0.36184	152	55	6	12	7
104	0.35928	167	60	4	11	22
105	0.35821	67	24	4	3	2
106	0.35135	111	39	3	10	7
107	0.35099	151	53	8	7	7
108	0.34286	140	48	6	9	6
109	0.33696	92	31	5	4	3
110	0.33333	117	39	2	9	13
111	0.33333	36	12	2	2	0
112	0.33333	33	11	2	0	3
113	0.33333	30	10	1	1	4
114	0.33000	100	33	3	6	9
115	0.32432	111	36	5	5	6
116	0.31731	104	33	5	3	7
117	0.31707	41	13	2	1	3
118	0.31690	142	45	6	8	5
119	0.31646	79	25	2	6	5
120	0.30909	110	34	5	6	2
121	0.30769	65	20	0	7	6
122	0.30081	123	37	7	3	3
123	0.29412	68	20	1	5	6
124	0.29412	17	5	0	2	1
125	0.28571	35	10	2	1	0
126	0.28523	298	85	11	15	11
127	0.28205	39	11	2	1	1
128	0.27922	154	43	7	6	3
129	0.27692	65	18	3	2	2
130	0.27500	40	11	2	0	3
131	0.27027	185	50	8	5	8
132	0.25806	62	16	2	4	0
133	0.25641	39	10	1	2	2
134	0.25352	71	18	2	3	4
135	0.24390	41	10	1	2	2
136	0.24324	37	9	1	2	1
137	0.24227	194	47	5	10	7
138	0.23256	86	20	2	3	6
139	0.22951	61	14	1	2	6
140	0.22727	66	15	0	6	3
141	0.22727	22	5	1	0	1

Table VII. SCORSORT SUMMARY (continued)

k	S_k	N_k	Z_k	X_{1k}	X_{2k}	X_{3k}
142	0.22642	53	12	1	3	2
143	0.22500	40	9	0	3	3
144	0.22222	162	36	4	6	8
145	0.22000	100	22	0	6	10
146	0.21875	64	14	2	2	2
147	0.21698	212	46	5	10	6
148	0.21384	159	34	1	10	10
149	0.21053	114	24	4	3	2
150	0.20988	81	17	2	2	5
151	0.20952	210	44	5	6	12
152	0.20588	68	14	1	3	4
153	0.20561	107	22	2	3	8
154	0.20000	80	16	3	1	2
155	0.19863	146	29	2	7	7
156	0.19780	91	18	1	4	6
157	0.19091	110	21	0	6	9
158	0.18288	514	94	10	19	16
159	0.18000	100	18	1	2	8
160	0.17647	51	9	2	0	1
161	0.17143	105	18	3	2	2
162	0.17045	88	15	2	3	1
163	0.16867	83	14	1	4	2
164	0.16783	143	24	1	7	6
165	0.16667	60	10	2	0	2
166	0.16667	36	6	1	0	2
167	0.16250	80	13	2	2	1
168	0.16250	80	13	1	2	5
169	0.15337	163	25	3	5	3
170	0.15126	119	18	2	2	6
171	0.14894	47	7	1	0	3
172	0.14815	27	4	0	2	0
173	0.14783	115	17	3	2	1
174	0.14516	62	9	2	0	1
175	0.14493	69	10	0	3	4
176	0.14458	83	12	2	2	0
177	0.13861	101	14	1	2	6
178	0.13580	81	11	2	1	1
179	0.13433	67	9	0	4	1
180	0.13333	30	4	1	0	0
181	0.12903	62	8	1	2	0
182	0.12821	156	20	2	4	4
183	0.12821	39	5	0	1	3
184	0.12745	102	13	1	2	5

Table VII. SCORSORT SUMMARY (continued)

k	S_k	N_k	Z_k	X_{1k}	X_{2k}	X_{3k}
185	0.12727	55	7	1	0	3
186	0.12658	79	10	1	2	2
187	0.12381	105	13	1	2	5
188	0.12245	49	6	1	1	0
189	0.11905	42	5	1	0	1
190	0.11864	118	14	2	2	2
191	0.11538	52	6	1	0	2
192	0.11483	209	24	3	4	4
193	0.11215	107	12	2	1	2
194	0.11009	109	12	1	2	4
195	0.10784	102	11	0	4	3
196	0.10588	85	9	1	1	3
197	0.10526	76	8	1	1	2
198	0.10448	67	7	1	1	1
199	0.10345	58	6	1	0	2
200	0.10345	58	6	1	1	0
201	0.10300	233	24	4	3	2
202	0.10227	88	9	0	4	1
203	0.10145	69	7	0	3	1
204	0.10112	89	9	0	4	1
205	0.10000	30	3	0	1	1
206	0.10000	10	1	0	0	1
207	0.09756	41	4	1	0	0
208	0.09655	145	14	1	3	4
209	0.08738	103	9	1	1	3
210	0.08333	180	15	0	5	5
211	0.08333	72	6	0	2	2
212	0.08333	24	2	0	1	0
213	0.08333	24	2	0	1	0
214	0.08163	49	4	0	1	2
215	0.08000	50	4	1	0	0
216	0.07843	51	4	0	2	0
217	0.07813	64	5	1	0	1
218	0.07692	52	4	0	1	2
219	0.07563	119	9	1	2	1
220	0.07547	53	4	1	0	0
221	0.07500	80	6	1	0	2
222	0.07407	108	8	1	2	0
223	0.07143	14	1	0	0	1
224	0.07092	141	10	0	3	4
225	0.06993	143	10	0	2	6
226	0.06944	72	5	0	1	3
227	0.06849	73	5	0	1	3

Table VII. SCORSORT SUMMARY (continued)

k	S_k	N_k	Z_k	X_{1k}	X_{2k}	X_{3k}
228	0.06667	15	1	0	0	1
229	0.05941	101	6	0	2	2
230	0.05195	77	4	0	2	0
231	0.05000	40	2	0	1	0
232	0.05000	20	1	0	0	1
233	0.04977	221	11	2	0	3
234	0.04918	183	9	0	3	3
235	0.04444	45	2	0	1	0
236	0.04054	74	3	0	1	1
237	0.04000	50	2	0	0	2
238	0.03896	77	3	0	0	3
239	0.03846	26	1	0	0	1
240	0.03704	81	3	0	1	1
241	0.03636	55	2	0	1	0
242	0.03265	245	8	0	1	6
243	0.03175	63	2	0	0	2
244	0.03125	64	2	0	1	0
245	0.02632	38	1	0	0	1
246	0.02542	118	3	0	1	1
247	0.02500	40	1	0	0	1
248	0.02353	85	2	0	1	0
249	0.02174	92	2	0	0	2
250	0.02105	95	2	0	1	0
251	0.02000	50	1	0	0	1
252	0.01563	64	1	0	0	1
253	0.01493	67	1	0	0	1
254	0.01136	88	1	0	0	1
255	0.01111	90	1	0	0	1
256	0.01053	95	1	0	0	1
257	0.00909	110	1	0	0	1
258	0.00000	244	0	0	0	0
259	0.00000	123	0	0	0	0
260	0.00000	97	0	0	0	0
261	0.00000	63	0	0	0	0
262	0.00000	56	0	0	0	0
263	0.00000	55	0	0	0	0
264	0.00000	55	0	0	0	0
265	0.00000	50	0	0	0	0
266	0.00000	50	0	0	0	0
267	0.00000	50	0	0	0	0
268	0.00000	47	0	0	0	0
269	0.00000	44	0	0	0	0
270	0.00000	41	0	0	0	0

Table VII. SCORSORT SUMMARY (concluded)

k	S_k	N_k	Z_k	X_{1k}	X_{2k}	X_{3k}
271	0.00000	39	0	0	0	0
272	0.00000	35	0	0	0	0
273	0.00000	34	0	0	0	0
274	0.00000	32	0	0	0	0
275	0.00000	31	0	0	0	0
276	0.00000	29	0	0	0	0
277	0.00000	29	0	0	0	0
278	0.00000	28	0	0	0	0
279	0.00000	27	0	0	0	0
280	0.00000	23	0	0	0	0
281	0.00000	23	0	0	0	0
282	0.00000	20	0	0	0	0
283	0.00000	19	0	0	0	0
284	0.00000	18	0	0	0	0
285	0.00000	14	0	0	0	0
286	0.00000	14	0	0	0	0
287	0.00000	9	0	0	0	0
288	0.00000	6	0	0	0	0
289	0.00000	6	0	0	0	0
290	0.00000	2	0	0	0	0

S_k is related to another statistic, Z_k, defined by

$$Z_k = \sum_{i=1}^{3} X_{ik} \cdot \overline{W}$$

It is easily recognized that

$$S_k = \frac{Z_k}{N_k} .$$

An analysis was conducted of the relationship between Z_k and N_k, where Z_k was the total points received by teacher k and N_k was the number of voters familiar with teacher k. A scatter diagram, Figure 4, was constructed and it was concluded from this diagram that no relationship more sophisticated than $Z_k = S_k W_k$ was warranted.

F. DOMINANCE

The data from the score statistics was used to generate other statistics to be used for award recipient selection. A method was needed to reduce the number of eligible

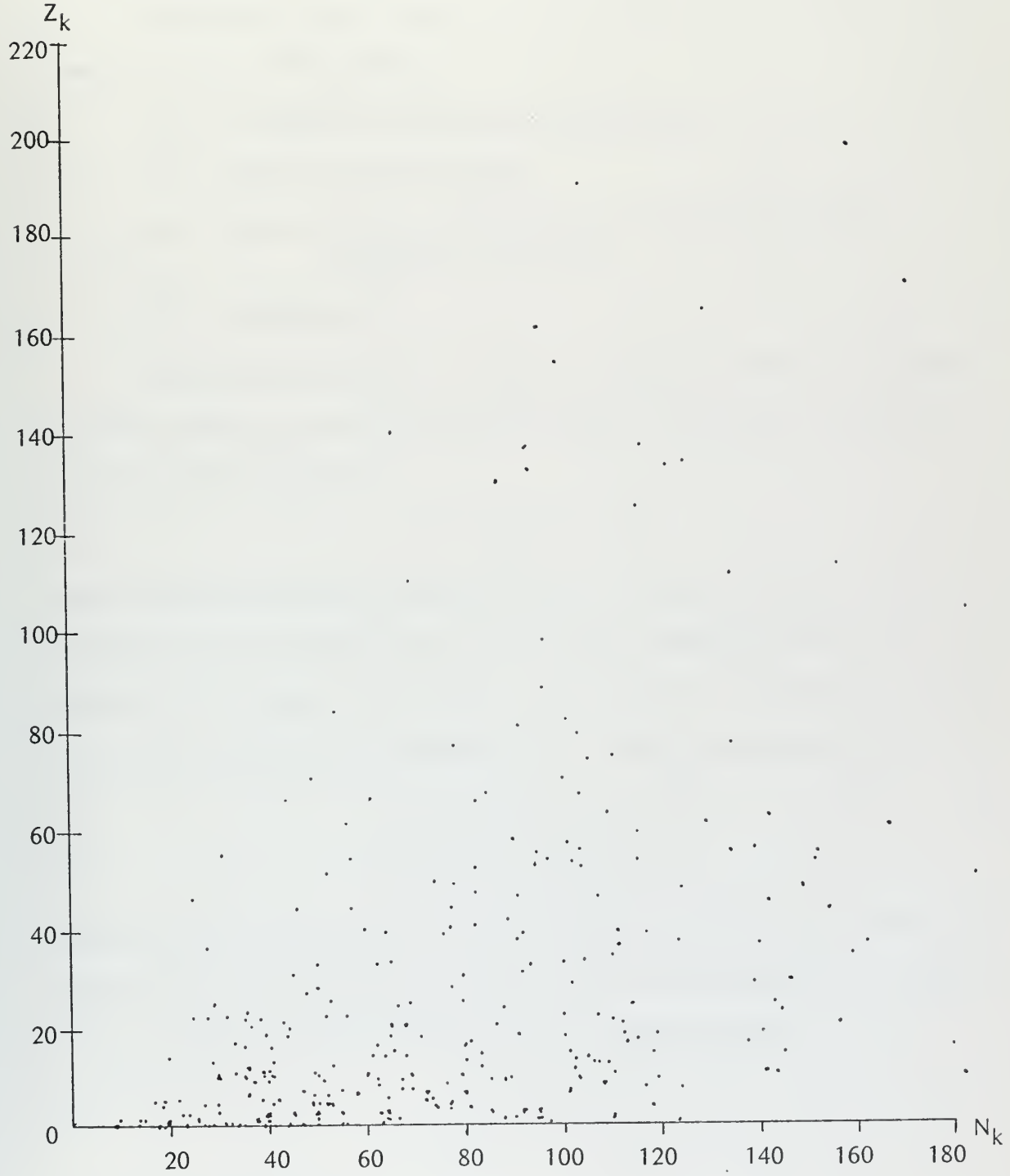

Figure 4. SCATTER DIAGRAM OF Z_k vs N_k

recipients without resorting to subjective guesses. Two methods for doing this were absolute dominance and complete dominance. These two concepts are discussed below.

1. Background

Associated with each teacher k, T_k, are statistics which give specific information about the individual. These include:

X_{ik} = the number of i^{th} place votes received by T_k

N_k = Number of voters knowing T_k

$v_{ik} = X_{ik}/N_k$ = fraction on i^{th} place votes awarded to T_k from the population that knew him

$\overline{W}$ = a weighting vector

The following structure for a preferential region was suggested by Professor T. Gawain, Chairman of the first Selection Committee. It would seem logical that $\overline{W}$ would be constrained such that

$$w_1 > w_2 > w_3 > 0$$

since a first place vote should be worth more than a second place vote which in turn should be worth more than a third place vote. Further, since weighting all place votes the same or giving one of the places a zero weight would be contrary to requesting three separate rankings, there must be greater restrictions on $\overline{W}$. In fact, it would seem logical to have

$$0 < a_1 \leq w_2/w_1 \leq b_1 < 1$$

and (2)

$$0 < a_2 \leq w_3/w_2 \leq b_2 < 1$$

where (a_1, b_1) and (a_2, b_2) define a preferential region interior to the unit square. The values of a_1, a_2, b_1 and b_2 would be chosen based on a determination of the smallest and largest ratios acceptable for the three rankings. This study used

$$a_1 = a_2 = 1/3$$

and

$$b_1 = b_2 = 2/3$$

as the acceptable parameters.

2. Development

It is desired to compare T_k's score, S_k,with other teachers scores, S_k'. The main interest lies in all values of $\overline{W}$ such that

$$S_k \geq S_k'$$

or

$$w_1V_{1k} + w_2V_{2k} + w_1V_{3k} \geq w_1V_{1k}' + w_2V_{2k}' + w_3V_{3k}' \qquad (3)$$

for all

$$K' \neq K.$$

rearranging (3) yields

$$w_1(V_{1k}-V_{1k}') + w_2(V_{2k}-V_{2k}') + w_3(V_{3k}-V_{3k}') \geq 0. \qquad (4)$$

Now if all values of $V_{ik} - V_{ik}' > 0$, i = 1,2,3, then $S_k > S_k'$ regardless of $\overline{W}$ and S_k' can be eliminated from competition. Thus, if T_k has a vector V_k such that $V_{ik} > V_{ik}'$, i = 1,2,3, then T_k absolutely dominates T_k'. This form of dominance is absolute dominance.

The next form of dominance eliminates all teachers who, in order to win, must have weighting systems that violate $w_1 \geq w_2 \geq w_3$. Divide (4) by w_2 and rearrange yielding

$$\frac{w_3}{w_2} \geq -\frac{V_{1k}-V_{1k}'}{V_{3k}-V_{3k}'}\,\frac{w_1}{w_2} - \frac{V_{2k}-V_{2k}'}{V_{3k}-V_{3k}'}, \qquad \begin{array}{l}\text{if } V_{3k} - V_{3k}' > 0,\\ \text{otherwise the sense of the}\\ \text{inequality is reversed}\end{array} \qquad (5)$$

Since the V_{ik} and V_{ik}' values are known, the dominance relationship is determined by the values of w_i, i = 1,2,3. For the appropriate values of w_i, i = 1,2,3, T_k is not dominated by T_k'.

Let $y = w_3/w_2$ and note that $0 \leq y \leq 1$. Let $X = w_1/w_2$ and note that $1 \leq X$ Then (5) becomes

$$y \geq -\frac{V_{1k}-V_{1k}'}{V_{3k}-V_{3k}'}\,X - \frac{V_{2k}-V_{2k}'}{V_{3k}-V_{3k}'}, \qquad \text{for } V_{3k} - V_{3k}' > 0.$$

Figure 5 gives a plot of y vs x. The shaded area indicates the feasible region for weights.

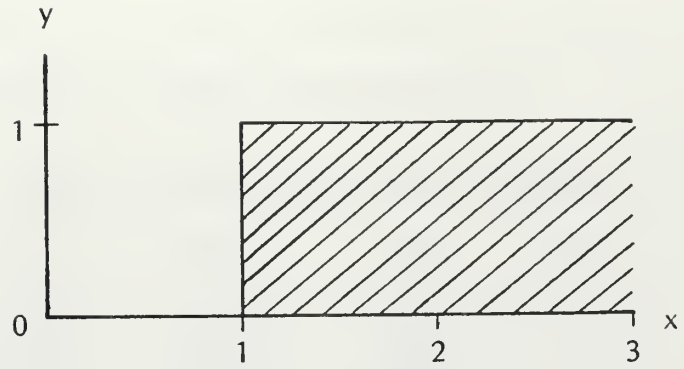

Figure 5. DOMINANCE PLOT

Now consider the boundary

$$y = \frac{V_{1k}'-V_{1k}}{V_{3k}-V_{3k}'} X + \frac{V_{2k}'-V_{2k}}{V_{3k}-V_{3k}'} .$$

This is the slope intercept form of the equation for a line. Analysing this indicates that for T_k to be completely dominated by T_k' either:

1) $\frac{V_{1k}'-V_{1k}}{V_{3k}-V_{3k}'} > 0$ and $y(1) > 1$, for $V_{3k} - V_{3k}' > 0$

2) $\frac{V_{1k}'-V_{1k}}{V_{3k}-V_{3k}'} < 0$ and $y(1) < 0$, for $V_{3k} - V_{3k}' < 0$

3) $V_{3k} - V_{3k}' = 0$ and

   a) $V_{1k} - V_{1k}' < 0$ and $\frac{V_{2k}-V_{2k}'}{V_{1k}-V_{1k}'} < 1$

   b) $V_{1k} - V_{1k}' = 0$ and $V_{2k} < V_{2k}'$

If any of these obtain, then T_k is completely dominated by T_k' otherwise there is no decision. T_k will be eliminated if he is completely dominated by at least one T_k'.

3. Results

A computer routine was prepared based on the above theory and dominance tests were run. Table VIII presents a summary of the data used and the results of the dominance tests. The AD column lists the results of the Abolute Dominance tests

employing a 1 to indicate T_k is absolutely dominated and a 0 to indicate it is not absolutely dominated. The CD column lists the results of the Complete Dominance tests using 1 and 0 as above to indicate complete domination.

Table VIII. DOMINANCE TESTS RESULTS

T_k	V_{1k}	V_{2k}	V_{3k}	AD	CD
1	0.394	0.242	0.061	0	0
2	0.440	0.134	0.060	0	0
3	0.320	0.240	0.080	0	1
4	0.365	0.135	0.096	0	1
5	0.355	0.161	0.032	1	1
6	0.305	0.189	0.095	0	1
7	0.351	0.117	0.052	1	1
8	0.267	0.217	0.129	0	1
9	0.290	0.174	0.087	1	1
10	0.253	0.222	0.101	0	1
11	0.278	0.148	0.130	0	1
12	0.273	0.114	0.182	0	1
13	0.290	0.118	0.075	1	1
14	0.224	0.204	0.122	1	1
15	0.226	0.204	0.108	1	1
16	0.214	0.143	0.143	0	1
17	0.240	0.116	0.085	1	1
18	0.222	0.140	0.104	1	1
19	0.189	0.189	0.113	1	1
20	0.216	0.138	0.043	1	1
21	0.182	0.089	0.174	1	1
22	0.214	0.107	0.018	1	1
23	0.200	0.096	0.096	1	1
24	0.197	0.098	0.098	1	1
25	0.160	0.176	0.080	1	1
26	0.198	0.063	0.104	1	1
27	0.146	0.146	0.117	1	1
28	0.179	0.090	0.090	1	1
29	0.154	0.154	0.058	1	1
30	0.174	0.109	0.043	1	1
31	0.175	0.070	0.105	1	1
32	0.146	0.115	0.104	1	1
33	0.125	0.167	0.083	1	1
34	0.154	0.088	0.099	1	1
35	0.172	0.069	0.034	1	1
36	0.112	0.142	0.097	1	1
37	0.098	0.159	0.098	1	1

Table VIII. DOMINANCE TESTS RESULTS (concluded)

T_k	V_{1k}	V_{2k}	V_{3k}	AD	CD
38	0.083	0.179	0.107	1	1
39	0.071	0.143	0.214	0	1
40	0.158	0.070	0.000	1	1
41	0.109	0.103	0.083	1	1
42	0.143	0.057	0.019	1	1
43	0.120	0.090	0.040	1	1
44	0.000	0.250	0.200	0	1
45	0.044	0.222	0.067	1	1
46	0.089	0.089	0.156	1	1
47	0.125	0.063	0.063	1	1
48	0.109	0.082	0.082	1	1
49	0.041	0.189	0.135	0	1
50	0.126	0.058	0.049	1	1

G. PAIRED COMPARISONS

1. Development

Assume a comparison of two teachers, T_k, T_k', under the constraint that the voters must know each of them. Let

$$N_{k,k'} = \sum_{i=1}^{N_o} y_{ik}\, y_{ik'}$$

where N_o = total number of ballots and y_{ik} is an indicator function whose value is one if ballot i was acquainted with T_k and zero otherwise. $N_{k,k'}$ represents the number of voters who knew both T_k and T_k'. Note that $N_{k,k'}$ is a symmetric matrix with zeroed diagonals.

In order to determine the scores of T_k and T_k', first determine $Z_k(k,k')$ and $Z_k(k',k)$ where $Z_k(k,k')$ represents the total score accumulated by T_k from the population of votes that knew both T_k and T_k'. Thus,

$$Z_k(k,k') = \sum_{i=1}^{N_o} y_{ik}y_{ik'}\,(w_1X_{i1k} + w_2X_{i2k} + w_3X_{i3k})$$

and

$$Z_k(k',k) = \sum_{i=1}^{N_o} y_{ik}y_{ik'}\,(w_1X_{i1k'} + w_2X_{i2k'} + w_3X_{i3k'})$$

where, X_{ijk} is the number of j^{th} place votes received by T_k on the i^{th} ballot.

Then,

$$S_k(k,k') = Z_k(k,k')/N_{k,k'}$$

and

$$S_k(k',k) = Z_k(k',k)/N_{k,k'}$$

$S_k(k,k')$ represents the score of T_k under the constraint that the voters knew both T_k and $T_{k'}$. A similar interpretation can be made for $S_k(k',k)$ and $T_{k'}$. Now a fraction $S_k(k,k')/S_k(k',k)$, is formed so that

1) If $S_k(k,k') > S_k(k',k)$ the value is greater than one.

2) If $S_k(k,k') < S_k(k',k)$ the value is less than one.

3) If $S_k(k,k') = S_k(k',k)$ the value is one.

A reversal is noted if $S_k > S_{k'}$ and 2) above occurs and a tie if 3) above occurs. By reversal is meant, the paired comparison fails to confirm the primary ordering of the two teachers. The significance of a reversal is enhanced the greater the value of $N_{k,k'}$.

2. Results

A computer routine based on the above theory was run using the data and a comparison was made for T_k, k=1, . . . , 7. Table IX presents the results of that run. In the table N is the number of voters who knew both T_k and $T_{k'}$.

H. COMMENTS

All individuals passing the dominance tests, zeros in both AD and CD, had the comment section of the ballots identifying them scrutinized and an abstract was made of the comments. In order to maintain complete objectivity of the selection committee all references to name or department were removed from the comment abstract.

I. THE SELECTION

Once all of the forementioned tests were performed and the results obtained, a set of statistics was prepared for the selection committee. This set of statistics included:

Table IX. PAIRED COMPARISONS

T_1

N	T_k	S_1/S_k
38	12	129/142 < 1
15	2	140/160 < 1
10	9	190/160 > 1
6	18	333/017 > 1
4	13	000/075 < 1
4	17	150/250 < 1

T_2

N	T_k	S_2/S_k
28	9	250/100 > 1
22	18	250/045 > 1
21	17	114/124 < 1
17	19	082/106 < 1
15	1	160/140 > 1
11	12	227/109 > 1
10	6	080/060 > 1
9	8	111/111 = 1
9	10	100/022 > 1
8	13	088/013 > 1
6	4	067/017 > 1

T_3

N	T_k	S_3/S_k
4	8	025/250 < 1
4	10	025/200 < 1
3	17	033/033 = 1

T_4

N	T_k	S_4/S_k
35	14	191/203 < 1
15	13	133/033 > 1
9	8	122/067 > 1
6	2	017/067 < 1
5	6	120/160 < 1
4	18	000/000 = 1
4	20	100/000 > 1
3	17	000/000 = 1

T_5

N	T_k	S_5/S_k
7	9	200/144 > 1
4	8	000/200 < 1
3	17	000/067 < 1
3	18	200/067 > 1

T_6

N	T_k	S_6/S_k
20	17	095/050 > 1
10	2	060/080 < 1
10	8	690/160 > 1
5	4	160/000 > 1
5	9	200/040 < 1
5	19	080/000 > 1
4	13	050/000 > 1
4	20	125/000 > 1
3	19	000/000 = 1
3	18	033/000 > 1

T_7

N	T_k	S_7/S_k
27	10	078/111 < 1
19	19	221/079 > 1
17	11	194/041 > 1
15	18	193/027 > 1
6	14	067/100 < 1
5	16	080/080 = 1
4	17	000/050 < 1
3	8	200/000 > 1
3	13	000/133 < 1

1) The results from the score calculations

2) The results of the Dominance Tests

3) The results of the paired comparison test

4) The comment abstract.

After deliberating for some time on the data, a decision was made for T_2. That individual was identified to the selection committee as Professor E. C. Haderlie of the Department of Oceanography.

IV. FURTHER ANALYSES

A. BACKGROUND AND SUMMARY

It was observed last year by Geary [ref. 3] that the distribution of scores could be represented by the mixed density

$$f_S(s) = q \qquad \text{for } s = 0$$

$$= p\lambda e^{-\lambda s} \qquad \text{for } s > 0$$

where $p + q = 1$ and $\lambda > 0$. The parameter values were $\hat{q} = .177$ and $\hat{\lambda} = 2.09$ for a population of $N = 249$ scores. The following questions were raised:

1. Does the above distribution type hold again this year? If so, have the parameters remained the same?

2. Is the distribution of scores the same for teachers who taught the quarter of the balloting and those who did not? If not, do the teachers who taught score better?

3. Are the teacher rankings produced this year in concordance with those produced last year?

These questions are addressed in subsections B, C, and D.

In summary,

1. The mixed exponential distribution still holds qith $\hat{q} = .114$, $\hat{\lambda} = 2.41$ and $N = 290$. The direction of the parameter changes was noteworthy in that it supported the hypothesis that the award was encouraging better teaching on a broad scale. The proportion of zero scores had decreased and the positive scores had smalier variability.

2. The segregating of teachers into two groups, those who taught in the quarter of the balloting and those who did not, resulted in score distributions which were still of the exponential type, but the parameterization changed. It was believed that those who did not teach would have lower scores, but the results were not conclusive. This is discussed in subsection C.

3. The Kendall Concordance Coefficient was computed. The value of 0.77 was mildly high, significantly above zero, but also significantly less than one.

B. SCORE DISTRIBUTION STUDY

Figure 6 is a histogram of S_k, the score of teacher k, $s > 0$, for FY '71. Note the reverse J-shape which indicates there is a good chance for the distribution of the scores to be exponential. The data for FY '70 had a similar histogram and Lieutenent Robert Geary [ref. 3] showed that the data was exponential with a density function

$$f_S(s) = 2.09\, e^{-2.09s},\ s > 0.$$

A similar assumption was made this year and the maximum likelihhod estimation procedure for the parameter λ was used. This results in

$$\overline{X} = \frac{1}{\hat{\lambda}}$$

where $\overline{x}$ is the mean of the sample of positive scores and is the parameter used in the exponential density function. Recall from Barr [ref. 1] that the probability density function of an exponential function is

$$f_X(x) = e^{-\lambda x},\ x \geq 0$$

The log of the likelihood equation is

$$n \ln\lambda - \lambda\Sigma U_j f_j$$

where U_j is the cell midpoint and f_j is the cell frequency. Setting the derivative of the above with respect to λ equal to zero yields

$$\overline{x} = \frac{1}{n}\sum_{j=1}^{n} U_j\, f_j k$$

thus

$$\hat{\lambda} = 1/\frac{1}{n}\sum_{j=1}^{n} U_j\, f_j.$$

Tables X through XVII show the data breakdown of the FY 70 and FY 71 data. Table XVIII shows the $\hat{\lambda}$values.

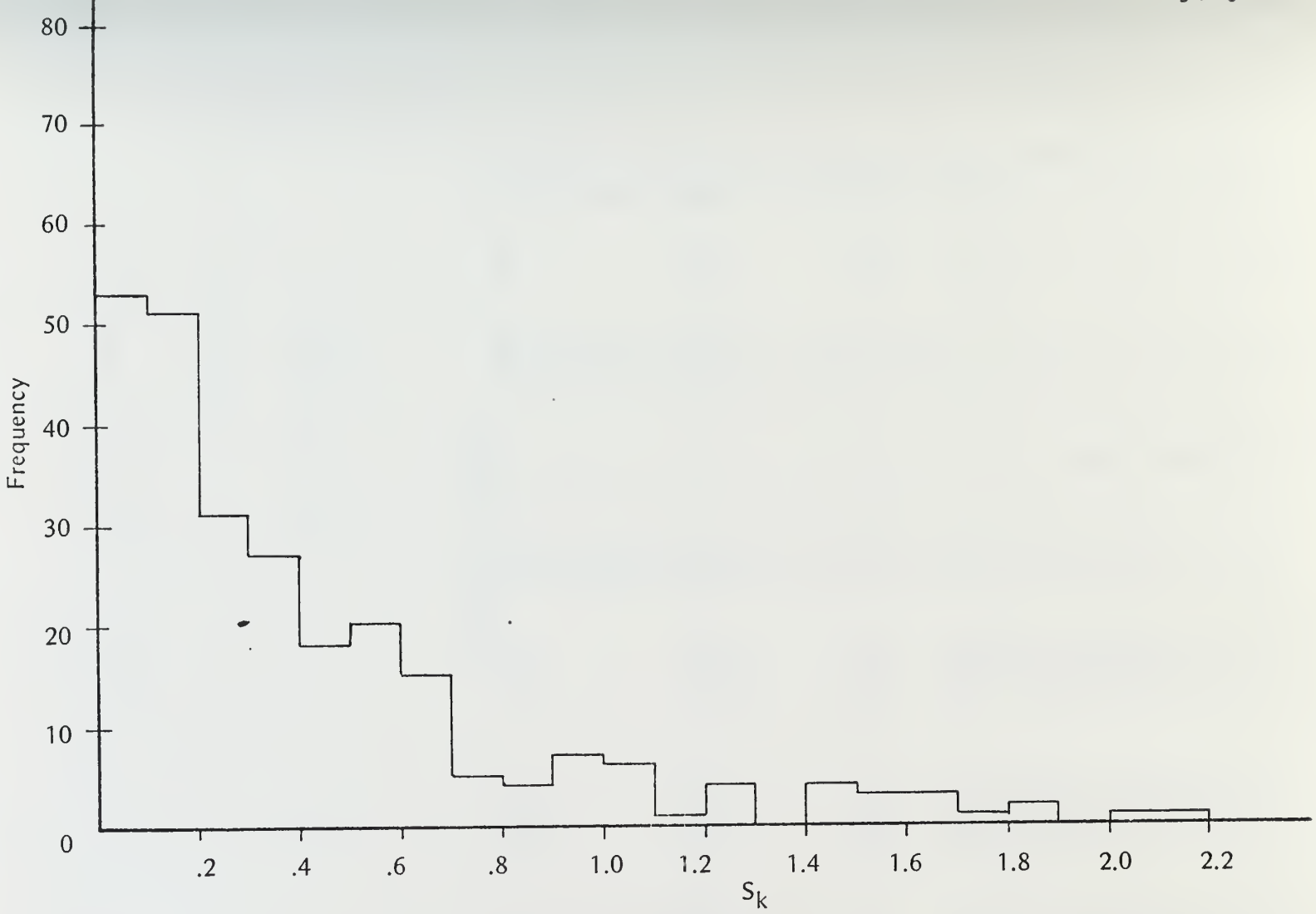

Figure 6. HISTOGRAM OF S_k

Table X. CHI SQUARE TEST DATA FY 70 ALL

j	k	U_j	F_j	U_jF_j	P_j	NP_j	F_j/NP_j
1	1	.05	42	2.10	.1894	38.83	45.43
2	2	.15	34	5.10	.1601	32.82	35.22
3	3	.25	23	5.75	.1232	25.26	20.94
4	4	.35	27	9.45	.0999	20.48	35.60
5	5	.45	13	5.85	.0844	17.30	9.77
6	6	.55	13	7.15	.0650	13.33	12.68
7	7	.65	5	3.25	.0526	10.78	2.32
8	8	.75	11	8.25	.0427	8.75	13.83
9	9	.85	7	5.95	.0361	7.40	6.62
10	10	.95	7	6.65	.0278	5.70	8.60
11		1.05	1	1.05			
12	11	1.15	3	3.45	.0415	8.51	1.88
13	12	1.25	5	6.25	.0146	2.99	8.36
14		1.35	1	1.35			
15		1.45	1	1.45			
16		1.55	1	1.55			
17	13	1.65	2	3.30	.0359	7.36	3.40
18	14	1.75	4	7.00	.0051	1.05	15.24
19		1.85	0	0.00			
20		1.95	0	0.00			
21		2.05	1	2.05			
22		2.15	0	0.00			
23		2.25	1	2.25			
24	15	2.35	3	7.05	.0217	4.45	5.62

N=205 $\sum U_j f_j = 96.25$

$$\bar{x} = \frac{1}{n} \sum_{j=1}^{24} U_j f_j = .4695$$

$$\hat{\lambda} = \frac{1}{\bar{x}} = 2.13$$

$$X^2_{15-2,.05} = \sum_{k=1}^{15} F_k/NP_k - N = 20.49$$

Table XI. CHI SQUARE TEST DATA FY 70, Q3, TEACHING

j	k	U_j	F_j	U_jF_j	P_j	NP_j	F_j/NP_j
1	1	.05	31	1.55	.1894	28.98	33.16
2	2	.15	23	3.75	.1536	23.50	26.60
3	3	.25	18	4.50	.1297	19.84	16.33
4	4	.35	22	7.70	.0999	15.28	31.68
5	5	.45	10	4.50	.0809	12.38	8.08
6	6	.55	5	2.75	.0657	10.05	2.46
7	7	.65	4	2.60	.0532	8.14	1.97
8	8	.75	7	5.25	.0449	6.87	7.13
9	9	.85	7	5.95	.0347	5.31	9.23
10	10	.95	7	6.65	.0280	4.28	11.45
11		1.05	1	1.05			
12		1.15	1	1.15			
13	11	1.25	5	6.25	.0567	8.68	5.64
14		1.35	1	1.35			
15		1.45	0	0.00			
16		1.55	1	1.55			
17		1.65	1	1.65			
18	12	1.75	4	7.00	.0414	6.33	7.74
19		1.85	0	0.00			
20		1.95	0	0.00			
21		2.05	0	0.00			
22		2.15	0	0.00			
23		2.25	1	2.25			
24	13	2.35	2	4.70	.0219	3.35	2.69

$N=153 \quad \sum U_j f_j = 72.15$

$$\bar{x} = \frac{1}{n} \sum_{j=1}^{24} U_j f_j = .47156$$

$$\hat{\lambda} = \frac{1}{\bar{x}} = 2.12$$

$$X^2_{13-2} = \sum_{k=1}^{13} F_k^2/NP_k - N = 11.15$$

Table XII. CHI SQUARE TEST DATA FY 70, Q3, NOT TEACHING

j	k	U_j	F_j	U_jF_j	P_j	NP_j	F_j/NP_j
1	1	.05	11	.55	.1975	10.27	11.78
2	2	.15	9	1.35	.1520	7.90	10.25
3	3	.25	5	1.25	.1285	6.68	3.74
4		.35	5	1.75			
5	4	.45	3	1.35	.1824	9.48	6.75
6	5	.55	8	4.40	.0671	3.49	18.34
7		.65	1	.65			
8	6	.75	4	3.00	.0952	4.95	5.05
9		.85	0	0.00			
10		.95	0	0.00			
11		1.05	0	0.00			
12		1.15	2	2.30			
13		1.25	0	0.00			
14		1.35	0	0.00			
15		1.45	1	1.45			
16		1.55	0	0.00			
17		1.65	1	1.65			
18		1.75	0	0.00			
19		1.85	0	0.00			
20		1.95	0	0.00			
21		2.05	1	2.05			
22		2.15	0	0.00			
23		2.25	0	0.00			
24	7	2.35	1	2.35	.1773	9.22	3.90

N=52 $\sum U_jf_j$=24.1

$$\bar{x} = \frac{1}{n} \sum_{j=1}^{24} U_jf_j = .46346$$

$$\hat{\lambda} = \frac{1}{\bar{x}} = 2.16$$

$$X^2_{7-2,.05} = \sum_{k=1}^{7} F_k^2/NP_k - N = 7.82$$

Table XIII. CHI SQUARE TEST DATA FY 70, Q4, TEACHING

j	k	U_j	F_j	U_jF_j	P_j	NP_j	F_j/NP_j
1	1	.05	30	1.50	.1975	28.44	31.65
2	2	.15	26	3.90	.1585	22.82	29.62
3	3	.25	13	3.25	.1323	19.05	8.87
4	4	.35	21	7.35	.1010	14.54	30.33
5	5	.45	9	4.05	.0811	11.68	6.93
6	6	.55	11	6.05	.0651	9.37	12.91
7	7	.65	5	3.25	.0523	7.53	3.32
8	8	.75	5	3.75	.0436	6.28	3.98
9	9	.85	5	4.25	.0333	4.80	5.21
10	10	.95	5	4.75	.0267	3.84	6.51
11		1.05	1	1.05			
12		1.15	2	2.30			
13	11	1.25	3	3.75	.0530	7.63	4.72
14		1.35	0	0.00			
15		1.45	1	1.45			
16		1.55	0	0.00			
17		1.65	1	1.65			
18	12	1.75	2	3.50	.0373	5.37	2.98
19		1.85	0	0.00			
20		1.95	0	0.00			
21		2.05	1	2.05			
22		2.15	0	0.00			
23		2.25	1	2.25			
24	13	2.35	2	4.70	.0183	2.64	6.06

N=144 $\sum U_jF_j=64.8$

$$\bar{x} = \frac{1}{n} \sum_{j=1}^{24} U_jF_j = .450$$

$$\hat{\lambda} = \frac{1}{\bar{x}} = 2.22$$

$$X^2_{13-2,.05} = \sum_{k=1}^{13} F_j^2/NP_k - N = 9.10$$

Table XIV. CHI SQUARE TEST DATA FY 70, Q4, NOT TEACHING

j	k	U_j	F_j	U_jF_j	P_j	NP_j	F_j/NP_j
1	1	.05	12	.60	.1730	10.55	13.65
2	2	.15	8	1.20	.1499	9.14	7.00
3	3	.25	10	2.50	.1172	7.15	13.99
4	4	.35	6	2.10	.1015	6.19	5.82
5		.45	4	1.80			
6	5	.55	2	1.10	.1449	8.84	4.07
7		.65	0	0.00			
8	6	.75	6	4.50	.1013	6.18	5.82
9		.85	2	1.70			
10		.95	2	1.90			
11		1.05	0	0.00			
12	7	1.15	1	1.15	.1149	7.01	2.57
13		1.25	2	2.50			
14		1.35	1	1.35			
15		.145	0	0.00			
16	8	1.55	1	1.55	.0523	3.19	5.02
17		1.65	1	1.65			
18		1.75	2	3.50			
19		1.85	0	0.00			
20		1.95	0	0.00			
21		2.05	0	0.00			
22		2.15	0	0.00			
23		2.25	0	0.00			
24	9	2.35	1	2.35	.0450	2.75	5.82

$N=61 \quad \sum U_jF_j=31.45$

$$\bar{x} = \frac{1}{n} \sum_{j=1}^{24} U_jF_j = .5156$$

$$\hat{\lambda} = \frac{1}{\bar{x}} = 1.94$$

$$X^2_{9-2,.05} = \sum_{k=1}^{9} F^2_k/NP_k - N = 3.75$$

Table XV. CHI SQUARE TEST DATA FY 71, ALL

j	k	U_j	F_j	U_jF_j	P_j	NP_j	F_j/NP_j
1	1	.05	53	2.65	.2212	56.85	49.41
2	2	.15	51	7.65	.1600	41.12	63.25
3	3	.25	31	7.75	.1320	33.92	28.33
4	4	.35	27	9.45	.1039	26.70	27.70
5	5	.45	18	8.10	.0847	21.77	14.88
6	6	.55	20	11.00	.0636	16.35	24.46
7	7	.65	15	9.75	.0501	12.88	17.47
8	8	.75	5	3.75	.0393	10.10	2.48
9	9	.85	4	3.40	.0310	7.97	2.01
10	10	.95	7	6.65	.0244	6.27	7.81
11	11	1.05	6	6.30	.0191	4.91	7.33
12		1.15	1	1.15			
13	12	1.25	4	5.00	.0260	6.68	3.74
14		1.35	0	0.00			
15	13	1.45	4	5.80	.0179	4.60	3.48
16		1.55	3	4.65			
17	14	1.65	3	4.95	.0104	2.67	13.48
18		1.75	1	1.75			
19		1.85	2	2.70			
20		1.95	0	0.00			
21		2.05	1	2.05			
22	14	2.15	1	2.15	.0164	4.21	5.94

N=257 $\sum U_jF_j=106.65$

$$\bar{x} = \frac{1}{n}\sum_{j=1}^{22} U_jF_j = .4149$$

$$\hat{\lambda} = \frac{1}{\bar{x}} = 2.41$$

$$X^2_{15-2,.05} = \sum_{k=1}^{15} F_k^2/NP_k - N = 14.38$$

Table XVI. CHI SQUARE TEST DATA FY 71, Q3, TEACHING

j	k	U_j	F_j	U_jF_j	P_j	NP_j	F_j/NP_j
1	1	.05	40	2.00	.2055	38.22	41.86
2	2	.15	29	4.35	.1569	29.18	28.82
3	3	.25	20	5.00	.1310	24.37	16.41
4	4	.35	22	7.70	.1041	19.36	25.00
5	5	.45	15	6.75	.0827	15.38	14.63
6	6	.55	14	7.70	.0631	11.74	16.70
7	7	.65	13	8.45	.0528	9.82	17.21
8	8	.75	5	3.75	.0419	7.79	3.21
9	9	.85	4	3.40	.0320	5.95	2.69
10	10	.95	5	4.75	.0267	4.97	5.03
11	11	1.05	4	4.20	.0212	3.94	4.06
12		1.15	1	1.15			
13	12	1.25	3	3.75	.0298	5.54	2.89
14		1.35	0	0.00			
15		1.45	3	4.35			
16		1.55	1	1.55			
17	13	1.65	2	3.30	.0312	5.80	6.21
18		1.75	1	1.75			
19		1.85	2	3.70			
20		1.95	0	0.00			
21		2.05	1	2.05			
22	14	2.15	1	2.15	.0211	3.92	6.38

N=186 $\sum U_jF_j$=81.8

$$\bar{x} = \frac{1}{n} \sum_{j=1}^{22} U_jF_j = .439$$

$$\hat{\lambda} = \frac{1}{\bar{x}} = 2.27$$

$$X^2_{14-2,.05} = \sum_{k=1}^{14} F_k^2/NP_k - N = 5.09$$

Table XVII. CHI SQUARE TEST DATA FY 71, Q3, NOT TEACHING

j	k	U_j	F_j	U_jF_j	P_j	NP_j	F_j/NP_j
1	1	.05	13	.65	.2442	17.34	9.75
2	2	.15	22	3.30	.1788	12.69	38.14
3	3	.25	11	2.75	.1410	10.01	12.09
4		.35	5	1.75			
5	4	.45	3	1.35	.1844	13.09	4.89
6		.55	6	3.30			
7	5	.65	2	1.30	.1065	7.56	8.47
8		.75	0	0.00			
9		.85	0	0.00			
10		.95	2	1.90			
11		1.05	2	2.10			
12		1.15	0	0.00			
13	6	1.25	1	1.25	.1172	8.32	3.00
14		1.35	0	0.00			
15		1.45	1	1.45			
16		1.55	2	3.10			
17		1.65	1	1.65			
18		1.75	0	0.00			
19		1.85	0	0.00			
20		1.95	0	0.00			
21		2.05	0	0.00			
22	7	2.15	0	0.00	.0279	1.98	8.08

N=71 $\sum U_jF_j$= 25.85

$$\bar{x} = \frac{1}{n} \sum_{j=1}^{22} U_jF_j = .364$$

$$\hat{\lambda} = \frac{1}{\bar{x}} = 2.75$$

$$X^2_{7-2,.05} = \sum_{k=1}^{7} F_k^2/NP_k - N = 13.41$$

Table XVIII. VALUES

Group	FY 70 Q3	FY 70 Q4	FY 71 Q3
All Teachers	2.13	2.13	2.41
Those Teaching	2.12	2.22	2.27
Those Not Teaching	2.16	1.94	2.75

A Chi-Square Goodness-of-Fit Test was used to test the hypothesis that the density functions determined using the parameters above were valid representations of their respective data. The null and alternate hypotheses for the above functions were

$$H_0: f_S(s) = \hat{\lambda} e^{-\hat{\lambda} s}, \; s > 0$$

$$H_1: H_0 \text{ false,}$$

where $\hat{\lambda}$ is the value for the parameter of the density function, n is the number of positive scores, $I_1, I_2, \ldots I_r$ represents the scoring intervals, $p_j = P(S \in I_j)$ under H_0, np_j is the expected number of entries in I_j under H_0 and F_j is the number of observed entries in I_j.

Define

$$z = \sum_{j=1}^{r} \frac{(F_j - NP_j)^2}{NP_j} = \sum_{j=1}^{r} \frac{F_j^2}{NP_j} - N$$

where $N = \sum_j F_j$. As n gets large, z approaches the Chi-square distribution function with r-2 degrees of freedom

Thus let

$$P[X^2_{r-2,(1-\alpha)} \geq \text{Obs Ts} | H_0] = p$$

Compare p with α and if

1. $p < \alpha$ then reject H_0,
2. $p > \alpha$ then accept H_0.

The values determined for p were:

Table XIX. p VALUES

Group	FY 70 Q3	FY 70 Q4	FY 71 Q3
All Teachers	.084	.084	.350
Those Teaching	.403	.613	.995
Those Not Teaching	.168	.800	.030

Thus, it was concluded from the p values that H_0 could not be rejected for reasonable levels of significance.

C. TEACHING EFFECT

The author felt a reasonable question arose during the data manipulation concerning the effect of teaching during the voting quarter on a teacher's ranking. It seemed logical that a voter would be more likely to rank a teacher who was currently instructing than one who was off for the quarter. This assumption was based on the conjecture that a person is more likely to hold a stronger opinion of a teacher he is associating with at the time than one he has had in the past.

To test this hypothesis it would be best to remove all non-student ballots, but this was not possible due to time constraints. The faculty from the Navy Management Systems Center were removed from the data for they do not teach by quarters.

Care had to be exercised for during the FY 70 period the balloting was done at the start of Quarter 4, Q4. Since it was felt that strong opinions could not be formed during the first two weeks of a quarter, the data for Q3 was also gathered. The FY 71 period did not present the problem for the balloting was done near the end of Q3 for that year.

Using the model

$$f_S(s) = q, \quad s = 0$$
$$= p\lambda e^{-\lambda s}, \quad s > 0$$

it is desired to test

$$H_0: q_1 = q_2 \quad \text{and} \quad \lambda_1 = \lambda_2$$

against

$$H_1: q_2 > q_1 \quad \text{and} \quad \lambda_2 > \lambda_1$$

The author knows of no standard practice for this statistical problem. The following ad hoc discussion will shed some light on the question.

> *Reject H_0 if $\hat{q}_2$ is sufficiently larger than $\hat{q}_1$ and $\hat{\lambda}_2$ is sufficiently larger that $\hat{\lambda}_1$.*

However, these estimates are not statistically independent and joint probability statements concerning them are difficult to calculate. In lieu of this, the pairs $\hat{\lambda}_1, \hat{\lambda}_2$ are examined separately from $\hat{q}_1$, $\hat{q}_2$.

Table XVIII showed that $\hat{\lambda}_2 > \hat{\lambda}_1$ in Quarter 3 of both years, but $\hat{\lambda}_2 < \hat{\lambda}_1$ in Q4 of FY 70. Thus, the direction of the shift was consonant with the discussion at the beginning of this section. To determine the significance of the change, some distribution theory is required.

Since

$$\frac{\hat{\lambda}_2}{\hat{\lambda}_1} = \frac{n_2}{n_1} \frac{X_1}{X_2}$$

where x_i is the sum of positive scores for group i and n_i is the number of positive scores; and since a positive score has an exponential distribution, it follows that

$$x_i \sim \Gamma(n_i, \lambda), \; 2\lambda x_i \sim X^2_{(2n_i)}$$

and it follows that

$$\frac{\hat{\lambda}_2}{\hat{\lambda}_1} \sim F_{2n_1, 2n_2}.$$

The p values are listed in Table XX.

Table XX. p VALUES FOR $\hat{\lambda}_2/\hat{\lambda}_1$

Year	Quarter	Test Statistic	d.f.	Approx. p Value
1970	3	2.16/2.12 = 1.019	104/306	.40
1970	4	1.94/2.22 = 0.874	122/288	.75
1971	3	2.75/2.27 = 1.211	142/372	.05

Turning to $\hat{q}_1$ and $\hat{q}_2$, the normal approximation will be used in the two sample case. Let

h_1 = percentage of zeroes of those professors teaching during the observed quarter.

h_2 = percentage of zeroes of those professors not teaching during the observed quarter.

Then

$$h = \frac{n_1 h_1 + n_2 h_2}{n_1 + n_2}$$

where h is the pooled percentage of all teachers, n_1 is the number of professors teaching during the observed quarter, and n_2 is the number of professors not teaching during the observed quarter. Now let

$$\hat{\sigma} = \sqrt{h(1-h)(1/n_1 + 1/n_2)} \quad ,$$

then from Brownlee [ref. 2]

$$\frac{(h_2 - 1/2n_2) - (h_1 + 1/2n_1)}{\hat{\sigma}} \approx N(0,1)$$

using this formula, solving for p values yields

Table XXI. p VALUES FOR q TEST

Observed Quarter	p Value
Q3, FY 70	.14
Q4, FY 70	.79
Q3, FY 71	.09

Again, the direction of the change supported the discussions at the beginning of this section, but the results were not significant using this as hoc approach. A sharper analysis may or may not give more significant support to this phenomenon. Such an analysis would include

1. Removal of the non-student ballots
2. Correct joint probability statements concerning $\hat{\lambda}_1, \hat{\lambda}_2, \hat{q}_1$, and $\hat{q}_2$.

D. CONCORDANCE ESTIMATION

Suppose that $X = (X^a, X^b)$ has a bivariate cumulative distribution function $F(x^a,x^b)$, then the vectors x_1 and x_2 are said to be concordant if $x_1^a - x_2^a$ and $x_1^b - x_2^b$ have the same sign. Further, using Kendall's [ref. 5] Coefficient of Concordance the commonality of two sets of data can be determined. If the test is performed and the coefficient of concordance is near one, the two sets of data show similar ranking. The further the coefficient is from one, near zero, the worse the relationship. Thus this test can be used to determine if a teacher scoring high one year is likely to score high the next. Also, it can be determined if the students rank the teachers the same each year.

Kendall, [ref. 5], defines the relationship as

$$W = \frac{12S}{m^2(n^3 - n) - 12m\sum T_i}$$

where S is the sum of squares of actual deviations, n is the number of rankings, m is the number of raters, $T_i = \sum_t(t^3 - t)$, and t indicate ties.

Table XXII is a 2 x 222 matrix of rankings determined from the scores.. The first row represents the ranking of teachers in FY 70 and the second row represents the ranking of the teachers in FY 71. The choice of 222 teachers was made so that the population would include only professors eligible both years.

From this table the values of the equation take the form

$$W = \frac{12(2743884.46)}{(2)^2\,[(222)^3 - 222] - 12(2)\,(47838)}$$

yielding

$$W = .77264$$

Kendall also expressed a method to determine the significance of the Concordance Coefficient. Let

$$X_r^2 = m(n-1)\,W = \frac{12S}{mn(n+1)}$$

where r = n-1, yielding

Table XXII. CONCORDANCE MATRIX

FY 70	1	2	3	4	5	6	7	8	9	10	11
FY 71	8	2	5	12	1	4	37	26	18	7	16
Total	9	4	8	16	6	10	34	34	27	17	27
FY 70	12	13	14	15	16	17	18	19	20	21	22
FY 71	19	194	25	41	30	11	9	79	136	33	40
Total	31	207	39	56	46	28	27	98	156	54	62
FY 70	23	24	25	26	27	28	29	30	31	32	33
FY 71	28	130	13	34	162	10	51	114	24	6	181
Total	51	154	38	60	189	38	80	144	55	38	214
FY 70	34	35	36	37	38	39	40	41	42	43	44
FY 71	74	20	29	21	14	52	75	26	23	176	48
Total	108	55	65	58	52	91	115	67	65	219	92
FY 70	45	46	47	48	49	50	51	52	53	54	55
FY 71	177	58	111	83	142	62	17	189	15	65	61
Total	222	104	158	131	191	112	68	241	68	119	116
FY 70	56	57	58	59	60	61	62	63	64	65	66
FY 71	100	96	59	39	31	42	134	72	70	108	137
Total	156	153	117	98	91	103	196	135	134	173	203
FY 70	67	68	68	70	71	72	73	74	75	76	77
FY 71	131	129	57	37	35	121	143	55	56	98	32
Total	198	197	125	107	106	193	216	129	131	174	109
FY 70	78	79	80	81	82	83	84	85	86	87	88
FY 71	122	46	123	135	33	49	83	109	131	65	88
Total	200	125	203	216	115	132	167	194	217	152	176
FY 70	89	90	91	92	93	94	95	96	97	98	99
FY 71	133	84	89	60	150	87	171	73	54	126	138
Total	222	174	180	152	243	181	266	169	151	224	237
FY 70	100	101	102	103	104	104	106	107	108	109	110
FY 71	154	134	82	116	64	166	80	125	113	197	146
Total	254	225	184	219	168	270	186	232	221	306	256
FY 70	111	112	113	114	115	116	116	118	119	120	121
FY 71	77	129	94	71	88	127	91	147	106	148	128
Total	188	241	207	185	203	243	207	265	225	268	249

Table XXII. CONCORDANCE MATRIX (concluded)

FY 70	122	123	123	123	126	127	128	129	129	131	132
FY 71	105	204	145	22	53	93	65	165	90	149	104
Totals	227	327	268	145	179	220	193	294	219	280	236
FY 70	133	134	135	136	137	138	139	140	141	142	143
FY 71	193	45	188	44	68	206	201	50	95	198	183
Total	326	179	323	180	205	344	340	190	236	340	326
FY 70	144	145	146	147	148	149	150	151	152	153	154
FY 71	170	159	102	175	69	173	178	140	139	63	119
Total	314	304	248	322	217	322	328	291	291	216	273
FY 70	155	156	157	158	159	160	161	162	163	164	165
FY 71	117	166	206	172	192	115	166	158	181	202	203
Total	272	322	363	330	351	275	327	320	344	366	368
FY 70	166	167	168	169	170	171	172	173	174	175	176
FY 71	99	101	152	161	174	47	180	107	112	92	206
Total	265	268	320	330	344	218	352	280	286	267	382
FY 70	177	178	179	180	181	182	183	184	185	186	187
FY 71	190	191	206	199	206	200	76	195	164	118	206
Total	367	369	385	379	387	382	259	379	349	304	393
FY 70	188	188	188	188	188	188	188	188	888	188	188
FY 71	143	160	184	153	206	151	186	120	157	206	206
Total	331	348	372	341	394	339	374	308	345	394	394
FY 70	188	188	188	188	188	188	188	188	188	188	188
FY 71	156	206	155	169	206	187	206	205	196	163	182
Total	344	394	343	357	394	375	394	393	384	351	370
FY 70	188	188	188	188	188	188	188	188	188	188	188
FY 71	185	206	206	141	85	110	206	97	36	179	3
Total	373	394	394	329	273	298	394	265	224	367	191
FY 70	188	188									
FY 71	206	206									
Total	394	394									

$$x_r^2 = 341.507$$

For values of r greater then 30, the quantity $\sqrt{2x_r^2}$ may be taken to be distributed normally about the mean, $\sqrt{2r-1}$. Thus

$$\sqrt{2x_r^2} \sim N(\sqrt{2r-1},\ 1)$$

or

$$\sqrt{2x_{221}^2} \sim N(\sqrt{441},\ 1)$$

or

$$\sqrt{2x_{221}^2} - 21 \quad N(0,1) \ .$$

So

$$P(\sqrt{2x_{221}^2} - 21 > z) = .05$$

or

$$\sqrt{2x_{221}^2} - 21 > 1.65$$

$$\Rightarrow \quad x_{221}^2 > 256.51$$

This specifies the critical region. Since

$$341.507 > x_{221}^2 = 256.51$$

it was concluded that the resulting W = .77 is substantially significant. This indicated that the rankings of teachers was not random and that a teacher's ranking was indicative, at least to a small extent, of the way the voting population as a whole felt about him.

V. CONCLUSIONS

The ballot format changes discussed in Section I are recommended. It is also recommended that a year to year update of accumulated balloting statistics be made as part of the automatic data processing. These include specifically

1. Tabulation of voter characteristics.
2. Computation of the mixed exponential parameters.
3. Concordance estimates be determined.

The study of the effect on the scores of teaching in the quarter of the balloting was inconclusive for the reasons given in Section IV. It is recommended that plans be made so that this question can be firmly resolved in the future.

APPENDIX A
SAMPLE BALLOT

SUPERINTENDENT'S AWARD FOR EXCELLENCE IN TEACHING

In order to augment the existing incentives for teaching of high quality, the Superintendent has established an award called the Superintendent's Award for Excellence in Teaching. The judgments of those who have participated in the educational processes at the Naval Postgraduate School are of primary importance. This poll is being conducted to assess the collective opinion of students, faculty, staff, and selected alumni. After accumulating and processing the voting results, the Selection Committee will recommend an Awardee to the Superintendent.

In view of the many measures of teaching excellence, there is no intent to fix the rationale by which each voter determines his nominations. However, in order to assist those voters who desire something more definite as a guide to their thinking, the following summary of some aspects of teaching excellence is offered as worthy of consideration: "The phrase, 'excellence in teaching,' refers to that complex of personal and professional qualities and actions on the part of the teacher which (a) make themselves felt primarily at the interface of personal contact between student and teacher; (b) help transmute the student's encounters with his subject matter into insight, enlightenment and love of learning; (c) elicit from the student responses in thought, feeling and action which enhance his capacity for self education and (d) manifest themselves in an effective individual style which authentically reflects the teacher's own unique personality, experience, character, and convictions."

A meaningful selection of the Award recipient is heavily dependent upon the receipt of nominations from a large portion of the eligible "voters". Your response is therefore earnestly requested. Please complete the enclosed ballot in accordance with the attached instructions. The results of the polling, other than the Award recipient, will be treated as privileged information.

BALLOTING PROCEDURE:

Step 0. Complete the information requested at the top (Part A) of the ballot. These items are for purposes of statistical analyses only.

Step 1. On the list of eligible faculty (Part C), encircle the four-digit identification number at the left of all those with whom you are sufficiently acquainted to make a judgment. Use your own guidelines. For purposes of establishing a valid population base, it is important to encircle <u>all</u> with whom you are acquainted. It is the judgment of the Selection Committee that you should be acquainted with at least five eligible faculty members in order to cast a meaningful ballot. Accordingly, if you have circled five or more numbers on the ballot, proceed to Step 2. Otherwise, please return your ballot as directed in Step 4.

Step 2. From the subset of faculty you have indicated in Step 1, select from one (1) to three (3) nominees. Indicate your preferences in order by placing the four-digit identification numbers of your nominees for first, second and third choices in the appropriate spaces provided in Part B.

Step 3. You are invited to furnish a short statement in support of your primary nomination. Space is provided for this at the end (Part D) of the ballot.

Step 4. Place your completed ballot in the enclosed return envelope, sign the envelope and return within ten days. Ballots will be separated from the envelopes.

BALLOT

Part A - Statistical (encircle code at left)

Voter Category

S Student
F Faculty
A Alumnus
C Curricular Officer

Military

Rank	Branch of Service	Curricular Area
01	N Navy	30 Ops Analysis
02	M Marine Corps	31 Aero Eng
03	A Army	32 Elec & Comm Eng
04	C Coast Guard	33 Ordnance
05	L Air Force	34 Naval Eng
06	F Foreign	35 Env Sci
07		36 Mange & Comptr Sci
		37 Eng Sci
		38 Baccalaureate
		39 Def Management

Civilian

Rank		Department	
IR	Instructor	AE	Aeronautics
AT	Assist Prof	AO	Aviation Safety
AC	Assoc Prof	MN	Bus Ad & Econ
PR	Professor	EE	Elec Eng
		GH	Govt & Humanities
		MC	Mat Sc & Chem
		MA	Math
		ME	Mech Eng
		MR	Meteorology
		OC	Oceanography
		OA	Ops Analysis
		PH	Physics
		NS	Navy Mange Sys Center

Part B - Nominations (use the four-digit identification number)

First choice_____Second choice_____Third choice_____

Part C - List of Eligible Faculty (all faculty engaged in teaching in the academic year (1970-71 except department chairmen and members of the selection committee)

Aviation Safety Programs

1014 Bomberger, R. B.
1025 Bradbury, C. M.
1036 Fletcher, J. L.
1047 Wible, L. C.

Department of Aeronautics

1058 Ball, R. E.
1069 Bennett, J. A. J.
1070 Biblarz, O.
1081 Collins, D. J.
1092 Gawain, T. H.
1108 Haupt, U.
1119 Kahr, C. H.
1120 Layton, D. M.
1131 Lindsey, G. H.
1142 Miller, J. A.
1153 Netzer, D. W.
1164 Platzer, M. F.
1175 Redlin, M. H.
1186 Schmidt, L. V.
1197 Vavra, M. H.
1203 Zucker, R. D.

Department of Business Administration and Economics

1214 Carrick, P. M.
1225 Church, W. H.
1236 Cowie, J. B.
1247 Darbyshire, L.
1258 Eisenhardt, P.
1269 Elster, R. S.
1270 Fremgen, J. M.
1281 Ganz, J. G.
1292 Githens, W. H.
1308 Grainger, T. L.
1319 Hoverland, H. A.
1320 Hynes, J. P.
1331 Jolly, J. A.
1342 Kushnick, S. A.
1353 Lande, R. S.
1364 Lane, H. L.
1375 Lee, M.
1386 McDonald, J. H.
1397 Moan, F. E.
1403 Noorzoy, S.
1414 Smith, J.
1425 Steckler, M. J.
1436 Vigen, J. W.
1447 Waibel, R.
1458 Wegener, W. H.
1469 Wiskoff, M. F.
1470 Womer, N. K.

Department of Electrical Engineering

1481 Adler, R. W.
1492 Badger, R.
1508 Bauer, W. M.
1519 Baycura, O. M.
1520 Borst, F. W., Jr.
1531 Bouldry, J. M.
1542 Breida, S.
1553 Campbell, J. D.
1564 Chan, S.
1575 Chaney, J. G.
1586 Cooper, P. E.
1597 Cotton, M. L.
1603 De Laura, R. D.
1614 Demetry, J. S.
1625 Ewing, G. D.
1636 Gardner, E. M.
1647 Geist, J. M.
1658 Gerba, A., Jr.
1669 Houston, R. K.
1670 Kirk, D. E.
1681 Klamm, C. F., Jr.
1692 Marmont, G. H.
1708 Miller, R. L.
1719 Murray, R. P.
1720 Myers, G. A.
1731 Myers, H. L.
1742 Oler, C. B.
1753 Panholzer, R.
1764 Rahe, G. A.
1775 Rothauge, C. H.
1786 Sackman, G. L.
1797 Sheingold, A.
1803 Smith, W. C.
1814 Spaugy, D. A.
1825 Stentz, D. A.
1836 Strum, R. D.
1847 Terman, F. W.
1858 Thaler, G. J.
1869 Titus, H. A.
1870 Turner, J. B., Jr.
1881 Ward, J. R.
1892 Wilcox, M. L.

Department of Government and Humanities

1908 Alexander, W. P.
1919 Amos, J. W., II
1920 Bjarnason, L. L.
1931 Boggess, W. C.
1942 Gabel, B. B.
1953 Gottschalk, S.
1964 McAdams, J. M.
1975 O'Neil, E. F.
1986 Pearson, L. W.
1997 Smith, B. M. L.
2006 Stolfi, R. H.
2017 Teti, F. M.

Department of Material Science and Chemistry

2028 Clark, J. R.
2039 Helliwell, R. W.
2040 Hering, C. A.
2051 Kinney, G. F.
2062 Leonesio, R. B.
2073 Reinhardt, R. A.
2084 Reynolds, M. F.
2095 Rowell, C. F.
2101 Sinclair, J. E.
2112 Tolles, W. M.
2123 Wilson, J. W.

Department of Mathematics

2134 Bender, A. P.
2145 Bleick, W. E.
2156 Bolles, R. C.
2167 Budway, J. J.
2178 Calabrese, P. G.
2189 Chewning, W. C.
2190 Comstock, C.
2206 Davis, D. L.
2217 Dixon, D. R.
2228 Estell, R. J.
2239 Faulkner, F. D.
2240 Franke, R.
2251 Giarratana, J.

2262 Gibbons, G. D.
2273 Hartkemeier, H. P.
2284 Hunt, R. W.
2295 Jayachandran, T.
2301 Jennings, W.
2312 Kildall, G. A.
2323 Kodres, U. R.
2334 Kolitz, B. L.
2345 Little, W. A.
2356 Litzler, L. G.
2367 Lucas, K. R.
2378 Marks, H. B.
2389 Morris, G. W.
2390 Pierce, J. P.
2406 Preisendorfer, R. W.
2417 Pulliam, F. M.
2428 Roberts, A. B.
2439 Schoenstadt, A. L.
2440 Schwarzkopf, A. B.
2451 Shorb, A. M.
2462 Singer, E. A.
2473 Spalding, J. H.
2484 Stewart, E. J.
2495 Stoops, G. A.
2501 Syms, G. H.
2512 Trahan, D. H.
2523 Wang, P. C. C.
2534 Weir, M. D.
2545 Wilde, C. O.

Department of Mechanical Engineering

2556 Brock, J. E.
2567 Cantin, G.
2578 Cooper, T. E.
2589 Garrison, C. J.
2590 Houlihan, T. M.
2606 Kelleher, M. D.
2617 Marto, P. J.
2628 Newton, R. E.
2639 Nguyen, D. H.
2640 Prowell, R. W.
2651 Salinas, D.
2662 Winfrey, R. C.

Department of Meteorology

2673 Alberty, R. L.
2695 Carrigan, R. C.
2684 Davidson, K. L.
2701 Duthie, W. D.
2712 Elsberry, R. L.
2723 Hamilton, H. D.
2734 Mahlman, J. D.
2745 Martin, F. L.
2756 Oakes, W.
2767 Schardt, D. L.
2778 Taylor, C. L.
2789 van der Bijl, W.
2790 Williams, R. T.
3915 Winninghoff, F. J.

Department of Oceanography

2806 Andrews, R. S.
2817 Bassett, C. H.
2828 Boston, N. E.
2839 Crew, H.
2840 Denner, W. W.
2851 Galt, J. A.
2862 Geary, J. E.
2873 Giles, C. F.
2884 Haderlie, E. C.
2895 Jung, G. H.
2901 Smith, R. J.
2912 Thompson, W. C.
2923 Thornton, E. B.
2934 Traganza, E. D.
2945 Tucker, S. P.
2956 von Schwind, J. J.
2967 Wickham, J. B.

Department of Operations Analysis

2978 Andrus, A. F.
2989 Arima, J. K.
2990 Barr, D. R.
3009 Barrett, E. B.
3010 Brill, E. A.
3021 Butterworth, R. W.
3032 Burnett, T. D.
3043 Capra, J. R.
3054 Cunningham, W. P.
3065 Danskin, J. M., Jr.
3076 Esary, J. D.
3087 Ferguson, R. L.
3098 Floyd, J. A.
3104 Free, W. D.
3115 Forrest, R. N.
3126 Gaver, D. P.
3137 Gieseke, W. J.
3148 Greenberg, H.
3159 Hartman, J. K.
3160 Heidorn, G. E.
3171 Higgins, J. E.
3182 Howard, G. T.
3193 Jones, C. R.
3209 Kalman, P. J.
3210 Karamadian, S.
3221 Kochems, R. A.
3232 Larson, H. J.
3243 Lindsey, G. F.
3254 McMasters, A. W.
3265 Marshall, K. T.
3276 Milch, P. R.
3287 Peterson, C. A.
3298 Poock, G. K.
3304 Preston, F. L.
3315 Richards, F. R.
3326 Schrady, D. A.
3337 Schwartz, H. J.
3348 Shubert, B. O.
3359 Shudde, R. H.
3360 Sovereign, M. G.
3371 Tarter, M. J.
3382 Taylor, J. G.
3393 Tuck, G. A.
3409 Tysver, J. B.
3410 Washburn, A. R.
3421 Woods, W. M.
3432 Zehna, P. W.
3443 Zweig, H. J.

Department of Physics

3454 Armstead, R. L.
3465 Buskirk, F. R.
3476 Ceglio, N. M.
3487 Cooper, A. W.
3498 Cooper, J. N.
3504 Coppens, A. B.
3515 Crittenden, E.C. Jr.
3526 Dahl, H. A.
3537 Eller, A. I.
3548 Garrettson, G. A.
3559 Handler, H. E.
3560 Harrison, D. E. Jr.
3571 Kalmbach, S. H.
3582 Kelly, R. L.
3593 Kinsler, L. E.
3609 Lipes, R. G.
3610 Little, W.
3621 Medwin, H.
3632 Milne, E. A.
3643 Neighbours, J. R.
3654 Olsen, L. O.
3665 Reese, W.
3676 Riggin, J. D.
3687 Rodeback, G. W.
3698 Sanders, J. V.
3704 Schacher, G. E.
3715 Schwirzke, F. R.
3726 Williamson, T. J.
3737 Woehler, K. E.
3748 Zeleny, W. B.

Navy Management System Center

3759 Blandin, S. W.
3760 Boynton, R. E.
3771 Cantrell, G. K.
3782 Childs, F. E.
3793 Dawson, J. E.
3809 De Serpa, A. C.
3810 Doran, E. J.
3821 Freed, E. J.
3832 Hartman, P. G.
3843 Keller, A. S.
3854 Mauer, W. A.
3865 Plotkin, N.
3876 Puscheck, H. C.
3887 von Pagenhardt, R.
3898 Ulrey, I. W.
3904 Wood, C. L.

Part D - Supporting remarks for your primary nomination (optional)

APPENDIX B

PROGRAM 1 TRANSFER

```
//   EXEC  COBFCLG
//COB.SYSIN DD *
       IDENTIFICATION DIVISION.
       PROGRAM-ID. 'TRANSFER'.
       AUTHOR. K.M.EISENHARDT.
       DATE-WRITTEN. APRIL,1970.
       INSTALLATION. NPS-MONTEREY.
       REMARKS.  TRANSFER PLACES THE CARD IMAGES OF EACH
                 BALLOT ON A TAPE AND CHECKS FOR KEYPUNCH ERRORS.
       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SOURCE-COMPUTER. IBM-360-67.
       OBJECT-COMPUTER. IBM-360-67.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
           SELECT CARD-FILE ASSIGN TO 'CARD' UTILITY.
           SELECT BALLOT-FILE ASSIGN TO 'BALLOT' UTILITY.
       DATA DIVISION.
       FILE SECTION.
       FD  CARD-FILE
           LABEL RECORD IS OMITTED
           RECORDING MODE IS F
           RECORD CONTAINS 80 CHARACTERS
           DATA RECORDS ARE BALLOT, BALLOT-CONT.
       01  BALLOT.
           02  STATISTICS.
               03  NUMBER                          PICTURE XXXX.
               03  VOTER                           PICTURE X.
               03  FILLER                          PICTURE X.
               03  MIL-RANK                        PICTURE XX.
               03  SERVICE                         PICTURE X.
               03  CURRICULUM                      PICTURE XX.
               03  ACAD-RANK                       PICTURE XX.
               03  DEPT                            PICTURE XX.
               03  COMMENT                         PICTURE X.
           02  INITIAL.
               03  A                               PICTURE 9.
               03  B                               PICTURE 9.
               03  C                               PICTURE 9.
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           03  D                                    PICTURE 9.
       02  SECOND.
           03  A                                    PICTURE 9.
           03  B                                    PICTURE 9.
           03  C                                    PICTURE 9.
           03  D                                    PICTURE 9.
       02  THIRD.
           03  A                                    PICTURE 9.
           03  B                                    PICTURE 9.
           03  C                                    PICTURE 9.
           03  D                                    PICTURE 9.
       02  PROF        OCCURS 12 TIMES.
           03  ELEMENT OCCURS 4 TIMES               PICTURE 9.
       02  FILLER                                   PICTURE XXXX.
01     BALLOT-CONT.
       02  NUMBER                                   PICTURE XXXX.
       02  CONTINUE                                 PICTURE X.
       02  FILLER                                   PICTURE X.
       02  POP       OCCURS 17 TIMES.
           03  EL OCCURS 4 TIMES                    PICTURE 9.
       02  FILLER                                   PICTURE XXXXXX.
FD     BALLOT-FILE
       LABEL RECORD IS OMITTED
       RECORDING MODE IS F
       BLOCK CONTAINS 3 RECORDS
       RECORD CONTAINS 477 CHARACTERS
       DATA RECORD IS BALLOT-RECORD.
01     BALLOT-RECORD.
       02  NUMBER                                   PICTURE XXXX.
       02  STATISTICS.
           03  VOTER                                PICTURE X.
           03  MIL-RANK                             PICTURE XX.
           03  SERVICE                              PICTURE X.
           03  CURRICULUM                           PICTURE XX.
           03  ACAD-RANK                            PICTURE XX.
           03  DEPT                                 PICTURE XX.
           03  COMMENT                              PICTURE X.
       02  ONE                                      PICTURE XXX.
       02  TWO                                      PICTURE XXX.
       02  THREE                                    PICTURE XXX.
       02  M                                        PICTURE 999.
       02  POPULATION  OCCURS 150 TIMES             PICTURE XXX.
WORKING-STORAGE SECTION.
77     I                                            PICTURE 999.
77     CHECK                                        PICTURE XXXX.
77     TEST                                         PICTURE 9.
77     ALPHA                                        PICTURE X.
77     CNTR          PICTURE 9999                   VALUE 0.
```

```
PROCEDURE DIVISION.
PREPARATION-SECTION.
    OPEN INPUT CARD-FILE,
         OUTPUT BALLOT-FILE.
INITIAL-CARD-SECTION.
    READ CARD-FILE RECORD AT END GO TO COMPLETION-SECTION.
ENTRY-1.
    MOVE NUMBER IN BALLOT TO CHECK.
    MOVE SPACES TO BALLOT-RECORD.
    MOVE 0 TO M.
STATISTICS-VERIFICATION.
M1.
    IF MIL-RANK IN BALLOT IS GREATER THAN '00' AND LESS
    THAN '08' THEN GO TO M2.
    IF MIL-RANK IN BALLOT IS EQUAL TO SPACES THEN GO TO M2.
    DISPLAY 'MIL-RANK        INCORRECT - BALLOT' CHECK.
    GO TO FIND-NEXT-BALLOT-1.
M2.
    IF SERVICE IN BALLOT IS EQUAL TO 'N' THEN GO TO M3.
    IF SERVICE IN BALLOT IS EQUAL TO 'M' THEN GO TO M3.
    IF SERVICE IN BALLOT IS EQUAL TO 'C' THEN GO TO M3.
    IF SERVICE IN BALLOT IS EQUAL TO 'A' THEN GO TO M3.
    IF SERVICE IN BALLOT IS EQUAL TO 'F' THEN GO TO M3.
    IF SERVICE IN BALLOT IS EQUAL TO 'L' THEN GO TO M3.
    IF SERVICE IN BALLOT IS EQUAL TO SPACES THEN GO TO M3.
    DISPLAY 'SERVICE         INCORRECT - BALLOT' CHECK.
    GO TO FIND-NEXT-BALLOT-1.
M3.
    IF CURRICULUM IN BALLOT IS GREATER THAN '29' AND LESS THAN
    '40' THEN GO TO M4.
    IF CURRICULUM IN BALLOT IS EQUAL TO SPACES THEN GO TO M4.
    DISPLAY 'CURRICULUM      INCORRECT - BALLOT' CHECK.
    GO TO FIND-NEXT-BALLOT-1.
M4.
    IF VOTER IN BALLOT IS EQUAL TO 'S' THEN GO TO BRANCH-JOINT.
    IF VOTER IN BALLOT IS EQUAL TO 'F' THEN GO TO FACULTY.
    IF VOTER IN BALLOT IS EQUAL TO 'A' THEN GO TO BRANCH-JOINT.
    IF VOTER IN BALLOT IS EQUAL TO 'C' THEN GO TO BRANCH-JOINT.
    IF VOTER IN BALLOT IS EQUAL TO SPACES
    THEN GO TO BRANCH-JOINT.
    DISPLAY 'VOTER           INCORRECT - BALLOT' CHECK.
    GO TO FIND-NEXT-BALLOT-1.
FACULTY.
    IF ACAD-RANK IN BALLOT IS EQUAL TO 'AT' THEN GO TO F4.
    IF ACAD-RANK IN BALLOT IS EQUAL TO 'AC' THEN GO TO F4.
    IF ACAD-RANK IN BALLOT IS EQUAL TO 'IR' THEN GO TO F4.
    IF ACAD-RANK IN BALLOT IS EQUAL TO 'PR' THEN GO TO F4.
    IF ACAD-RANK IN BALLOT IS EQUAL TO SPACES THEN GO TO F4.
```

```
    DISPLAY 'ACAD-RANK      INCORRECT - BALLOT' CHECK.
    GO TO FIND-NEXT-BALLOT-1.
F4.
    IF DEPT IN BALLOT IS EQUAL TO 'MN' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'EE' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'MA' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'OA' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'PH' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'AE' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'MR' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'ME' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'OC' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'NS' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'MC' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'GH' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO 'AO' THEN GO TO BRANCH-JOINT.
    IF DEPT IN BALLOT IS EQUAL TO SPACES THEN GO TO BRANCH-JOINT.
    DISPLAY 'DEPT           INCORRECT - BALLOT' CHECK.
    GO TO FIND-NEXT-BALLOT-1.
BRANCH-JOINT.
    IF COMMENT IN BALLOT IS EQUAL TO '0' OR '1' THEN GO TO
    DIGIT-CHECK-1.
    DISPLAY 'COMMENT        INCORRECT - BALLOT' CHECK.
    GO TO FIND-NEXT-BALLOT-1.
DIGIT-CHECK-1.
    MOVE INITIAL TO ONE.
    IF ONE IS EQUAL TO SPACES THEN GO TO C1.
    MULTIPLY 3.0 BY A IN INITIAL.
    MULTIPLY 5.0 BY B IN INITIAL.
    ADD A IN INITIAL, B IN INITIAL, C IN INITIAL GIVING TEST.
    IF TEST IS NOT EQUAL TO D IN INITIAL
    THEN DISPLAY 'INITIAL          INCORRECT - BALLOT' CHECK,
    GO TO FIND-NEXT-BALLOT-1.
C1.
    MOVE SECOND TO TWO.
    IF TWO IS EQUAL TO SPACES THEN GO TO C2.
    MULTIPLY 3.0 BY A IN SECOND.
    MULTIPLY 5.0 BY B IN SECOND.
    ADD A IN SECOND, B IN SECOND, C IN SECOND GIVING TEST.
    IF TEST IS NOT EQUAL TO D IN SECOND
    THEN DISPLAY 'SECOND           INCORRECT - BALLOT' CHECK,
    GO TO FIND-NEXT-BALLOT-1.
C2.
    MOVE THIRD TO THREE.
    IF THREE IS EQUAL TO SPACES THEN GO TO MOVE-1.
    MULTIPLY 3.0 BY A IN THIRD.
    MULTIPLY 5.0 BY B IN THIRD.
    ADD A IN THIRD, B IN THIRD, C IN THIRD GIVING TEST.
```

```
    IF TEST IS NOT EQUAL TO D IN THIRD
    THEN DISPLAY 'THIRD          INCORRECT - BALLOT' CHECK,
    GO TO FIND-NEXT-BALLOT-1.
MOVE-1.
    MOVE CORRESPONDING STATISTICS IN BALLOT TO STATISTICS
    IN BALLOT-RECORD.
    MOVE NUMBER IN BALLOT TO NUMBER IN BALLOT-RECORD.
    MOVE 0 TO I.
LOOP-1.
    ADD 1 TO I.
    MOVE ELEMENT (I, 1) TO ALPHA.
    IF ALPHA IS EQUAL TO SPACES THEN GO TO WRITE-TAPE.
    ADD 1 TO M.
    MOVE PROF (I) TO POPULATION (M).
    MULTIPLY 3.0 BY ELEMENT (I, 1).
    MULTIPLY 5.0 BY ELEMENT (I, 2).
    ADD ELEMENT (I, 1), ELEMENT (I, 2), ELEMENT (I, 3)
    GIVING TEST.
    IF TEST IS EQUAL TO ELEMENT (I, 4) THEN GO TO DUMMY-1.
    DISPLAY 'DIGIT ERROR        ' M '        BALLOT'
    NUMBER IN BALLOT.
FIND-NEXT-BALLOT-1.
    READ CARD-FILE RECORD AT END GO TO COMPLETION-SECTION.
    IF NUMBER IN BALLOT IS EQUAL TO CHECK THEN
    GO TO FIND-NEXT-BALLOT-1.
    GO TO ENTRY-1.
DUMMY-1.
    IF I IS NOT EQUAL TO 12 GO TO LOOP-1.
CONTINUATION-CARD-SECTION.
    READ CARD-FILE AT END GO TO COMPLETION-SECTION.
    IF NUMBER IN BALLOT IS NOT EQUAL TO CHECK GO TO ROUTE.
    MOVE 0 TO I.
LOOP-2.
    ADD 1 TO I.
    MOVE EL (I, 1) TO ALPHA.
    IF ALPHA IS EQUAL TO SPACES GO TO WRITE-TAPE.
    ADD 1 TO M.
    MOVE POP (I) TO POPULATION (M).
    MULTIPLY 3.0 BY EL (I, 1).
    MULTIPLY 5.0 BY EL (I, 2).
    ADD EL (I, 1), EL (I, 2), EL (I, 3) GIVING TEST.
    IF TEST IS EQUAL TO EL (I, 4) THEN GO TO DUMMY-2.
    DISPLAY 'DIGIT ERROR        ' M '        BALLOT'
    NUMBER IN BALLOT.
FIND-NEXT-BALLOT-2.
    READ CARD-FILE AT END GO TO COMPLETION-SECTION.
    IF NUMBER IN BALLOT IS EQUAL TO CHECK THEN
    GO TO FIND-NEXT-BALLOT-2.
```

```
            GO TO ENTRY-1.
        DUMMY-2.
            IF I IS EQUAL TO 17 GO TO CONTINUATION-CARD-SECTION.
            GO TO LOOP-2.
        ROUTE.
            IF VOTER IN BALLOT IS NOT EQUAL TO 'X' THEN ADD 1 TO CNTR,
            WRITE BALLOT-RECORD, GO TO ENTRY-1.
        ROUTE-2.
            IF VOTER IN BALLOT IS NOT EQUAL TO 'X' THEN GO TO ENTRY-1.
            DISPLAY 'SEQUENCE ERROR    ' NUMBER IN BALLOT
            '     BALLOT' CHECK.
            READ CARD-FILE RECORD AT END GO TO COMPLETION-SECTION.
            GO TO ROUTE-2.
        WRITE-TAPE.
            ADD 1 TO CNTR.
            WRITE BALLOT-RECORD.
            GO TO INITIAL-CARD-SECTION.
        COMPLETION-SECTION.
            DISPLAY 'NUMBER OF BALLOTS ADDED TO TAPE   ' CNTR.
            CLOSE CARD-FILE, BALLOT-FILE.
            STOP RUN.
//GO.BALLOT   DD   DSNAME=BALL,UNIT=2400,VOL=SER=NPS140,LABEL=(,NL),    *
//      DISP=(NEW,KEEP),DCB=(RECFM=FB,LRECL=477,BLKSIZE=1431)
//GO.CARD      DD  *,DCB=BLKSIZE=80
```

PROGRAM 2 PROFSORT

```
//  EXEC  COBFCLG,REGION.GO=100K,TIME.GO=2
//COB.SYSIN   DD  *
       IDENTIFICATION DIVISION.
       PROGRAM-ID. 'PROFSORT'.
       AUTHOR. K.M.EISENHARDT.
       INSTALLATION. NPGS-MONTEREY.
       DATE-WRITTEN. APRIL, 1970.
       REMARKS. PROFSORT BUILDS PROF-FILE WHICH IS ORGANIZED BY
                ASCENDING PROF-NUMBER FROM BALLOT-FILE WHICH IS
                RANDOMLY ORGANIZED BY BALLOT.
       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SOURCE-COMPUTER. IBM-360-67.
       OBJECT-COMPUTER. IBM-360-67.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
           SELECT BALLOT-FILE ASSIGN TO 'BALLOT' UTILITY.
           SELECT PROF-FILE ASSIGN TO 'SORTOUT' UTILITY.
           SELECT GRAPH-FILE ASSIGN TO 'GRAPH' UTILITY.
       DATA DIVISION.
       FILE SECTION.
       FD  BALLOT-FILE
           LABEL RECORDS ARE OMITTED
           RECORDING MODE IS F
           BLOCK CONTAINS 3 RECORDS
           RECORD CONTAINS 477 CHARACTERS
           DATA RECORD IS BALLOT-RECORD.
       01  BALLOT-RECORD.
           02  NUMBER                              PICTURE XXXX.
           02  STATISTICS.
               03  VOTER                           PICTURE X.
               03  MIL-RANK                        PICTURE XX.
               03  SERVICE                         PICTURE X.
               03  CURRICULUM                      PICTURE XX.
               03  ACAD-RANK                       PICTURE XX.
               03  DEPT                            PICTURE XX.
               03  COMMENT                         PICTURE 9.
           02  ONE                                 PICTURE XXX.
           02  TWO                                 PICTURE XXX.
           02  THREE                               PICTURE XXX.
           02  M                                   PICTURE 999.
           02  POPULATION  OCCURS 150 TIMES        PICTURE XXX.
       FD  PROF-FILE
           LABEL RECORDS ARE OMITTED
           RECORDING MODE IS F
```

```
     BLOCK CONTAINS 50 RECORDS
     RECORD CONTAINS 22 CHARACTERS
     DATA RECORD IS PROF-RECORD.
01   PROF-RECORD.
     02   BALLOT-NUMBER                          PICTURE XXXX.
     02   PROF.
          03   NUMBER                            PICTURE XXX.
          03   VOTE                              PICTURE 9.
          03   COMMENT                           PICTURE 9.
     02   VOTER.
          03   CATEGORY                          PICTURE X.
          03   MILITARY.
               04   RANK                         PICTURE XX.
               04   SERVICE                      PICTURE X.
               04   CURRICULUM                   PICTURE XX.
          03   CIVILIAN.
               04   RANK                         PICTURE XX.
               04   DEPT                         PICTURE XX.
     02   M-TOTAL                                PICTURE 999.
FD   GRAPH-FILE
     LABEL RECORDS ARE OMITTED
     RECORDING MODE IS F
     BLOCK CONTAINS 25 RECORDS
     RECORD CONTAINS 133 CHARACTERS
     DATA RECORD IS GRAPH-RECORD.
01   GRAPH-RECORD.
     02   GRAPH      OCCURS 133 TIMES           PICTURE X.
SD   SORT-FILE
     RECORDING MODE IS F
     RECORD CONTAINS 22 CHARACTERS
     DATA RECORD IS SORT-RECORD.
01   SORT-RECORD.
     02   BALLOT-SORT                           PICTURE XXXX.
     02   PROF-SORT                             PICTURE XXX.
     02   VOTE-SORT                             PICTURE 9.
     02   COMMENT-SORT                          PICTURE 9.
     02   STATISTICS-SORT.
          03   VOTER                            PICTURE X.
          03   MIL-RANK                         PICTURE XX.
          03   SERVICE                          PICTURE X.
          03   CURRICULUM                       PICTURE XX.
          03   ACAD-RANK                        PICTURE XX.
          03   DEPT                             PICTURE XX.
     02   M-SORT                                 PICTURE 999.
WORKING-STORAGE SECTION.
77   CNTR     PICTURE 9999    COMPUTATIONAL-3     VALUE 0000.
77   INDEX    PICTURE 999999  COMPUTATIONAL-3     VALUE 000000.
77   K                  PICTURE 99                VALUE 00.
```

```
77  J                       PICTURE 9          VALUE 0.
77  I                                          PICTURE 999.
77  M-MEAN  PICTURE  99999  VALUE 00000.
77  M-VAR   PICTURE 999999  VALUE 000000.
77  MEAN                                      PICTURE ZZ9.99999.
77  VAR                                       PICTURE ZZ9.99999.
77  DODO                                      PICTURE 999V99999.
77  DUMDUM                                    PICTURE 999V99999.
77  SCRIPT                                    PICTURE 999.
01  VARIABLES.
    02  POINTS   OCCURS 200 TIMES             PICTURE 999.
PROCEDURE DIVISION.
    SORT SORT-FILE ON ASCENDING KEY PROF-SORT,
    INPUT PROCEDURE INITIAL,
    GIVING PROF-FILE.
    STOP RUN.
INITIAL SECTION.
    OPEN INPUT BALLOT-FILE,
         OUTPUT GRAPH-FILE.
    MOVE ZEROES TO VARIABLES.
    MOVE SPACES TO GRAPH-RECORD.
    MOVE '
-   'FREQUENCY DISTRIBUTION OF M' TO GRAPH-RECORD.
    WRITE GRAPH-RECORD AFTER ADVANCING 0 LINES.
    MOVE SPACES TO GRAPH-RECORD.
    MOVE '          0         10        20        30        40
-   '    50        60        70        80        90       100'
    TO GRAPH-RECORD.
    WRITE GRAPH-RECORD AFTER ADVANCING 2 LINES.
    MOVE SPACES TO GRAPH-RECORD.
    MOVE '          0000000000C000000000000C000000000000000000000
-   '0000000000C000000000000C000000000000000000000000000000000000
-   '00' TO GRAPH-RECORD.
    WRITE GRAPH-RECORD AFTER ADVANCING 1 LINES.
READ-BALLOT-FILE.
    READ BALLOT-FILE RECORD AT END GO TO COMPLETION.
    DISPLAY NUMBER IN BALLOT-RECORD, M.
    IF M < 001 THEN GO TO READ-BALLOT-FILE.
    IF M > 200 THEN GO TO READ-BALLOT-FILE.
    ADD 1 TO CNTR.
    MOVE 0 TO I.
    PERFORM LOOP THRU LOOPEND M TIMES.
    ADD 1 TO POINTS (M).
    ADD M TO M-MEAN.
    COMPUTE M-VAR ROUNDED = M * M + M-VAR.
    GO TO READ-BALLOT-FILE.
LOOP.
    ADD 1 TO I.
```

```
           MOVE SPACES TO SORT-RECORD.
           MOVE POPULATION (I) TO PROF-SORT.
           MOVE NUMBER IN BALLOT-RECORD TO BALLOT-SORT.
           MOVE 0 TO VOTE-SORT.
           MOVE 0 TO COMMENT-SORT.
           MOVE CORRESPONDING STATISTICS TO STATISTICS-SORT.
           MOVE M TO M-SORT.
           IF POPULATION (I) IS EQUAL TO ONE
               THEN MOVE 3 TO VOTE-SORT, MOVE COMMENT IN BALLOT-RECORD
               TO COMMENT-SORT, GO TO LOOPEND.
           IF POPULATION (I) IS EQUAL TO TWO
               THEN MOVE 2 TO VOTE-SORT, GO TO LOOPEND.
           IF POPULATION (I) IS EQUAL TO THREE
               THEN MOVE 1 TO VOTE-SORT.
       LOOPEND.
           ADD 1 TO INDEX.
           RELEASE SORT-RECORD.
       GRAPH-ROUTINE.
           MOVE SPACES TO GRAPH-RECORD.
           ADD 1 TO K.
           IF K IS NOT EQUAL TO 10 THEN GO TO GRAPH-CONT.
           MOVE ZERO TO K.
           IF J IS EQUAL TO 9 THEN GO TO GRAPH-CONT.
           ADD 1 TO J.
           MOVE J TO GRAPH (8).
           MOVE '5' TO GRAPH (9).
       GRAPH-CONT.
           MOVE 'C' TO GRAPH (10).
           ADD 10, POINTS (I) GIVING SCRIPT.
           IF SCRIPT > 133 DISPLAY SCRIPT.
           MOVE '*' TO GRAPH (SCRIPT).
           WRITE GRAPH-RECORD AFTER ADVANCING 1 LINES.
       COMPLETION.
           MOVE SPACES TO GRAPH-RECORD.
           MOVE 5 TO I.
           PERFORM GRAPH-CONT.
           PERFORM GRAPH-ROUTINE THRU GRAPH-CONT VARYING I FROM 6
           BY 1 UNTIL I IS EQUAL TO 130.
           DISPLAY 'TOTAL INPUT RECORDS     ' CNTR.
           DISPLAY 'TOTAL SORTED RECORDS    ' INDEX.
           DIVIDE CNTR INTO M-MEAN GIVING DODO ROUNDED.
           DIVIDE CNTR INTO M-VAR GIVING DUMDUM ROUNDED.
           COMPUTE DUMDUM ROUNDED = DUMDUM - DODO * DODO.
           MOVE DUMDUM TO VAR.
           MOVE DODO TO MEAN.
           DISPLAY 'M-MEAN          ' MEAN.
           DISPLAY 'M-VAR           ' VAR.
           COMPUTE VAR ROUNDED = DUMDUM ** 0.5.
```

```
           DISPLAY 'SDN                ' VAR.
           CLOSE BALLOT-FILE, GRAPH-FILE.
//GO.SYSOUT DD SYSOUT=A,SPACE=(CYL,(3,2))
//GO.SORTPR  DD  SYSOUT=A
//GO.SORTLIB DD DSNAME=SYS1.SORTLIB,DISP=OLD
//GO.SORTWK01  DD UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK02  DD UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK03  DD UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK04  DD UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK05  DD UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK06  DD UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.BALLOT   DD  DSNAME=BALL,UNIT=2400,VOL=SER=NPS140,LABEL=(,NL),      *
//        DISP=(OLD,KEEP),DCB=(RECFM=FB,LRECL=477,BLKSIZE=1431)
//GO.SORTOUT DD DSNAME=PRO,UNIT=2400,VOL=SER=NPS262,LABEL=(,NL),         *
//    DISP=(OLD,KEEP),DCB=(RECFM=FB,LRECL=22,BLKSIZE=1100)
//GO.GRAPH    DD  SYSOUT=A,DCB=(RECFM=FB,LRECL=133,BLKSIZE=3325)
```

PROGRAM 3 SCORSORT

```
//     EXEC   COBFCLG,REGION.GO=125K,TIME.GO=2
//COB.SYSIN    DD  *
       IDENTIFICATION DIVISION.
       PROGRAM-ID. 'SCORSORT'.
       AUTHOR. K.M.EISENHARDT.
       INSTALLATION. NPGS-MONTEREY.
       DATE-WRITTEN. APRIL,1970.
       REMARKS. SCORSORT COMPUTES THE EXCELLENCE SCORE OF EACH PROFESSOR
                AND ORGANIZES THESE RESULTS BY DESCENDING SCORE AND
                DESCENDING NUMBER OF ACQUAINTENCES.
       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SOURCE-COMPUTER. IBM-360-67.
       OBJECT-COMPUTER. IBM-360-67.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
           SELECT PROF-FILE ASSIGN TO 'PROF' UTILITY.
           SELECT SCOR-FILE ASSIGN TO 'SCORE' UTILITY.
           SELECT GRAPH-FILE ASSIGN TO 'GRAPH' UTILITY.
       DATA DIVISION.
       FILE SECTION.
       FD  PROF-FILE
           LABEL RECORDS ARE OMITTED
           RECORDING MODE IS F
           BLOCK CONTAINS 50 RECORDS
           RECORD CONTAINS 22 CHARACTERS
           DATA RECORD IS PROF-RECORD.
       01  PROF-RECORD.
           02  FILLER                          PICTURE XXXX.
           02  PROF.
               03  NUMBER                      PICTURE XXX.
               03  VOTE                        PICTURE 9.
               03  COMMENT                     PICTURE 9.
           02  VOTER.
               03  CATEGORY                    PICTURE X.
               03  MILITARY.
                   04  RANK                    PICTURE XX.
                   04  SERVICE                 PICTURE X.
                   04  CURRICULUM              PICTURE XX.
               03  CIVILIAN.
                   04  RANK                    PICTURE XX.
                   04  DEPT                    PICTURE XX.
           02  M-TOTAL                         PICTURE 999.
       FD  SCOR-FILE
           LABEL RECORDS ARE OMITTED
```

```
     RECORDING MODE IS F
     BLOCK CONTAINS 25 RECORDS
     RECORD CONTAINS 133 CHARACTERS
     DATA RECORD ARE SCOR-RECORD, HEADING-RECORD.
01   SCOR-RECORD.
     02  FILLER                                  PICTURE X(6).
     02  PROF                                    PICTURE XXX.
     02  FILLER                                  PICTURE X(10).
     02  CALCULATIONS.
         03  SK                                  PICTURE 9.99999.
         03  FILLER                              PICTURE XXX.
         03  NK                                  PICTURE ZZ9.
         03  FILLER                              PICTURE XXX.
         03  ZK                                  PICTURE ZZ9.
         03  FILLER                              PICTURE XXX.
         03  DK                                  PICTURE ZZ9.
         03  FILLER                              PICTURE X(6).
         03  X1K                                 PICTURE ZZ9.
         03  FILLER                              PICTURE XXX.
         03  X2K                                 PICTURE ZZ9.
         03  FILLER                              PICTURE XXX.
         03  X3K                                 PICTURE ZZ9.
         03  FILLER                              PICTURE X(6).
         03  DIFF                                PICTURE ZZ9.
         03  FILLER                              PICTURE XXX.
         03  V1K                      PICTURE 9.999.
         03  FILLER                              PICTURE XXX.
         03  V2K                      PICTURE 9.999.
         03  FILLER                              PICTURE XXX.
         03  V3K                      PICTURE 9.999.
         03  FILLER                   PICTURE X(35).
01   HEADING-RECORD.
     02  HEADER-FIELDS                           PICTURE X(133).
FD   GRAPH-FILE
     LABEL RECORDS ARE OMITTED
     RECORDING MODE IS F
     BLOCK CONTAINS 25 RECORDS
     RECORD CONTAINS 133 CHARACTERS
     DATA RECORD IS GRAPH-RECORD.
01   GRAPH-RECORD.
     02  GRAPH       OCCURS 133 TIMES            PICTURE X.
SD   SORT-FILE
     RECORDING MODE IS F
     RECORD CONTAINS 49 CHARACTERS
     DATA RECORD IS SORT-RECORD.
01   SORT-RECORD.
     02  PROF-SORT                               PICTURE XXX.
     02  VOTER-SORT.
```

```
            03  CATEGORY-SORT                          PICTURE X.
            03  MILITARY-SORT.
                04  RANK                               PICTURE XX.
                04  SERVICE                            PICTURE X.
                04  CURRICULUM                         PICTURE XX.
            03  CIVILIAN-SORT.
                04  RANK                               PICTURE XX.
                04  DEPT                               PICTURE XX.
        02  SK-SORT                                    PICTURE  9V99999.
        02  NK-SORT                                    PICTURE 999.
        02  ZK-SORT                                    PICTURE 999.
        02  DK-SORT                                    PICTURE 999.
        02  X1K-SORT                                   PICTURE 999.
        02  X2K-SORT                                   PICTURE 999.
        02  X3K-SORT                                   PICTURE 999.
        02  V1K-SORT                          PICTURE  9V999.
        02  V2K-SORT                          PICTURE  9V999.
        02  V3K-SORT                          PICTURE  9V999.
WORKING-STORAGE SECTION.
77  CNTR                  PICTURE 999999      COMPUTATIONAL-3.
77  INDEX                 PICTURE 999         COMPUTATIONAL-3.
77  DUMMY                 PICTURE 9V999       COMPUTATIONAL-3.
77  DODO                  PICTURE 9999V9999   COMPUTATIONAL-3.
77  DUMDUM                PICTURE 9999V9999   COMPUTATIONAL-3.
77  DOPEY                                     PICTURE 999.
77  I                                         PICTURE 999.
77  SCRIPT                                    PICTURE 999.
77  MEAN                                      PICTURE ZZZ9.999.
77  VAR                                       PICTURE ZZZ9.999.
77  N-VAR                 PICTURE 999999      VALUE 000000.
77  N-MEAN                PICTURE 999999      VALUE 000000.
77  K                      PICTURE 99          VALUE 00.
77  J                      PICTURE 9           VALUE 0.
77  WEIGHT-FIRST          PICTURE 9           VALUE 4.
77  WEIGHT-SECOND         PICTURE 9           VALUE 2.
77  WEIGHT-THIRD          PICTURE 9           VALUE 1.
01  GRAPH-AID.
    02  POINTS  OCCURS 700 TIMES                      PICTURE 999.
01  IDS.
    02  IDENT                                         PICTURE XXX.
    02  IDENT-NUM   REDEFINES IDENT                   PICTURE 999.
01  VARIABLES.
    02  X   OCCURS 4 TIMES                            PICTURE 999.
01  HEADING-FORMAT.
    02  FILLER                PICTURE X(6)        VALUE SPACES.
    02  PROF                  PICTURE XXXX        VALUE 'PROF'.
    02  FILLER                PICTURE X(10)       VALUE SPACES.
    02  S                     PICTURE X(7)        VALUE ' SCORE '.
```

```
           02  FILLER                  PICTURE XXX        VALUE SPACES.
           02  N                       PICTURE XXX        VALUE 'NK '.
           02  FILLER                  PICTURE XXX        VALUE SPACES.
           02  Z                       PICTURE XXX        VALUE 'ZK '.
           02  FILLER                  PICTURE XXX        VALUE SPACES.
           02  D                       PICTURE XXX        VALUE 'DK '.
           02  FILLER                  PICTURE X(6)       VALUE SPACES.
           02  X1                      PICTURE XXX        VALUE 'X1K'.
           02  FILLER                  PICTURE XXX        VALUE SPACES.
           02  Y                       PICTURE XXX        VALUE 'X2K'.
           02  FILLER                  PICTURE XXX        VALUE SPACES.
           02  Z                       PICTURE XXX        VALUE 'X3K'.
           02  FILLER                  PICTURE X(6)       VALUE SPACES.
           02  DI                      PICTURE XXX        VALUE 'DIF'.
           02  FILLER                  PICTURE XXX        VALUE SPACES.
           02  V1                      PICTURE XXX        VALUE 'V1K'.
           02  FILLER                  PICTURE XXXX       VALUE SPACES.
           02  V2                      PICTURE XXX        VALUE 'V2K'.
           02  FILLER                  PICTURE X(5)       VALUE SPACES.
           02  V3                      PICTURE XXX        VALUE 'V3K'.
           02  FILLER                  PICTURE X(36)      VALUE SPACES.
       PROCEDURE DIVISION.
           SORT SORT-FILE ON DESCENDING KEY SK-SORT,
           DESCENDING KEY NK-SORT,
           INPUT PROCEDURE INITIAL,
           OUTPUT PROCEDURE FINISH.
           STOP RUN.
       INITIAL SECTION.
           OPEN INPUT PROF-FILE,
           OUTPUT GRAPH-FILE, SCOR-FILE.
           MOVE ZEROES TO GRAPH-AID.
           MOVE ZERO TO CNTR.
           MOVE ZERO TO INDEX.
       PRINT-GRAPH-HEADING-AND-GRID.
           MOVE SPACES TO GRAPH-RECORD.
           MOVE '
      -    'FREQUENCY DISTRIBUTION OF NK' TO GRAPH-RECORD.
           WRITE GRAPH-RECORD AFTER ADVANCING 0 LINES.
           MOVE SPACES TO GRAPH-RECORD.
           MOVE '          0         10        20        30        40
      -    '    50' TO GRAPH-RECORD.
           WRITE GRAPH-RECORD AFTER ADVANCING 2 LINES.
           MOVE SPACES TO GRAPH-RECORD.
           MOVE '          0000000000000000000000000000000000000000000000000
      -    '0000000000000000000000000000000000000000000000000000000000000000
      -    '00' TO GRAPH-RECORD.
           WRITE GRAPH-RECORD AFTER ADVANCING 1 LINES.
       READ-INITIAL-PROF-RECORD.
```

```
    READ PROF-FILE RECORD AT END GO TO COMPLETION.
    DISPLAY PROF-RECORD.
    ADD 1 TO CNTR.
    MOVE ZEROES TO SORT-RECORD.
    MOVE ZEROES TO VARIABLES.
    MOVE NUMBER TO IDENT.
    GO TO INTERMEDIATE-CALCULATIONS.
READ-PROF-FILE.
    READ PROF-FILE RECORD AT END GO TO COMPLETION.
    ADD 1 TO CNTR.
    IF NUMBER IS NOT EQUAL TO IDENT GO TO RESULT-CALCULATIONS.
INTERMEDIATE-CALCULATIONS.
    ADD COMMENT TO OK-SORT.
    ADD 1 TO NK-SORT.
    IF VOTE IS EQUAL TO 3 ADD WEIGHT-FIRST TO ZK-SORT.
    IF VOTE IS EQUAL TO 2 ADD WEIGHT-SECOND TO ZK-SORT.
    IF VOTE IS EQUAL TO 1 ADD WEIGHT-THIRD TO ZK-SORT.
    ADD 1 TO VOTE.
    ADD 1 TO X (VOTE).
    GO TO READ-PROF-FILE.
RESULT-CALCULATIONS.
    DISPLAY NK-SORT.
    DIVIDE NK-SORT INTO ZK-SORT GIVING SK-SORT ROUNDED.
    MOVE X (4) TO X1K-SORT.
    MOVE X (3) TO X2K-SORT.
    MOVE X (2) TO X3K-SORT.
    DIVIDE NK-SORT INTO X1K-SORT GIVING V1K-SORT ROUNDED.
    DIVIDE NK-SORT INTO X2K-SORT GIVING V2K-SORT ROUNDED.
    DIVIDE NK-SORT INTO X3K-SORT GIVING V3K-SORT ROUNDED.
RELEASE-TO-SORT.
    MOVE IDENT TO PROF-SORT.
    MOVE VOTER TO VOTER-SORT.
    ADD 1, NK-SORT GIVING DOPEY.
    ADD 1 TO POINTS (DOPEY).
    RELEASE SORT-RECORD.
    ADD 1 TO INDEX.
ZERO-RESULTS.
    MOVE ZEROES TO SORT-RECORD.
    MOVE ZEROES TO VARIABLES.
    MOVE NUMBER TO IDENT.
    GO TO INTERMEDIATE-CALCULATIONS.
GRAPH-ROUTINE.
    MOVE SPACES TO GRAPH-RECORD.
    ADD 1 TO K.
    IF K IS NOT EQUAL TO 10 THEN GO TO GRAPH-CONT.
    MOVE ZERO TO K.
    IF J IS EQUAL TO 9 THEN GO TO GRAPH-CONT.
    ADD 1 TO J.
```

```
    MOVE J TO GRAPH (8).
    MOVE '0' TO GRAPH (9).
GRAPH-CONT.
    MOVE '0' TO GRAPH (10).
    ADD 10, POINTS (I) GIVING SCRIPT.
    MOVE '*' TO GRAPH (SCRIPT).
    WRITE GRAPH-RECORD AFTER ADVANCING 1 LINES.
COMPLETION.
    DISPLAY 'NUMBER OF RECORDS ON PROF-FILE          ' CNTR.
    DISPLAY 'NUMBER OF RECORDS RELEASED TO SORT      ' INDEX.
    PERFORM GRAPH-ROUTINE THRU GRAPH-CONT VARYING I FROM 2
    BY 1 UNTIL I IS EQUAL TO 700.
    CLOSE GRAPH-FILE, PROF-FILE.
FINISH SECTION.
    MOVE ZERO TO INDEX.
    MOVE ZERO TO CNTR.
    MOVE ZERO TO DOPEY.
    MOVE HEADING-FORMAT TO HEADER-FIELDS.
    WRITE HEADING-RECORD AFTER ADVANCING 0 LINES.
RETURN-SORT-FILE.
    IF CNTR IS EQUAL TO 75 THEN PERFORM HEADER-ROUTINE.
    IF CNTR IS EQUAL TO 150 THEN PERFORM HEADER-ROUTINE.
    IF CNTR IS EQUAL TO 225 THEN PERFORM HEADER-ROUTINE.
    IF CNTR IS EQUAL TO 300 THEN PERFORM HEADER-ROUTINE.
    RETURN SORT-FILE AT END GO TO WRAPUP.
    ADD 1 TO INDEX.
    MOVE SPACES TO SCOR-RECORD.
    MOVE SPACES TO PROF IN SCOR-RECORD.
    MOVE SK-SORT TO SK.
    MOVE NK-SORT TO NK.
    MOVE ZK-SORT TO ZK.
    MOVE DK-SORT TO DK.
    MOVE X1K-SORT TO X1K.
    MOVE X2K-SORT TO X2K.
    MOVE X3K-SORT TO X3K.
    SUBTRACT X1K-SORT, X2K-SORT, X3K-SORT FROM NK-SORT GIVING
    DIFF.
    MOVE V1K-SORT TO V1K.
    MOVE V2K-SORT TO V2K.
    MOVE V3K-SORT TO V3K.
WRITE-RECORD.
    ADD NK-SORT TO N-MEAN.
    COMPUTE N-VAR ROUNDED = NK-SORT * NK-SORT + N-VAR.
    WRITE SCOR-RECORD AFTER ADVANCING 1 LINES.
    ADD 1 TO CNTR.
    GO TO RETURN-SORT-FILE.
HEADER-ROUTINE.
    MOVE SPACES TO HEADER-FIELDS.
```

```
           MOVE HEADING-FORMAT TO HEADER-FIELDS.
           WRITE HEADING-RECORD AFTER ADVANCING 0 LINES.
       WRAPUP.
           DISPLAY 'NUMBER OF RECORDS RETURNED FROM SORT    ' INDEX.
           DISPLAY 'NUMBER OF RECORDS PRINTED               ' CNTR.
           DISPLAY '                   '.
           DISPLAY '                   '.
           DISPLAY '                   '.
           SUBTRACT DOPEY FROM CNTR.
           DIVIDE CNTR INTO N-MEAN GIVING DODO ROUNDED.
           DIVIDE CNTR INTO N-VAR GIVING DUMDUM ROUNDED.
           COMPUTE DUMDUM ROUNDED = DUMDUM - DODO * DODO.
           MOVE DUMDUM TO VAR.
           MOVE DODO TO MEAN.
           DISPLAY 'N-MEAN             ' MEAN.
           DISPLAY 'N-VAR              ' VAR.
           COMPUTE VAR ROUNDED = DUMDUM ** 0.5.
           DISPLAY 'SDN                ' VAR.
           CLOSE SCOR-FILE.
//GO.SYSOUT DD SYSOUT=A,SPACE=(CYL,(5,1))
//GO.SORTPR DD SYSOUT=A
//GO.SORTLIB DD DSNAME=SYS1.SORTLIB,DISP=OLD
//GO.SORTWK01   DD  UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK02   DD  UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK03   DD  UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK04   DD  UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK05   DD  UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.SORTWK06   DD  UNIT=SYSDA,SPACE=(TRK,(20),,CONTIG)
//GO.PROF    DD DSNAME=PRO,UNIT=2400,VOL=SER=NPS262,LABEL=(,NL),        *
//     DISP=(OLD,KEEP),DCB=(RECFM=FB,LRECL=22,BLKSIZE=1100)
//GO.SCORE     DD    SYSOUT=A,DCB=(RECFM=FB,LRECL=133,BLKSIZE=3325)
//GO.GRAPH DD SYSOUT=A,DCB=(RECFM=FB,LRECL=133,BLKSIZE=3325)
```

PROGRAM 4 DOMINANCE

```
//  EXEC WATFORG
//SYSIN DD *
$JOB  JOB (0071.0036WT.0211).'BOX216'
C     THIS PROGRAM MAKES BOTH AN ABSOLUTE AND COMPLETE DOMINANCE TEST
C     FOR EACH OF THE PROFESSORS READ IN. THE PRINTOUT SHOWS A ZERO UNDER
C     THE AD COLUMN IF THE PROFESSOR IS NOT ABSOLUTELY DOMINATED. OTHER-
C     WISE A ONE IS PLACED UNDER THE AD COLUMN. THE COMPLETE DOMINANCE
C     COLUMN HAS THE SAME NOTATION FOR COMPLETE DOMINANCE RESULTS FOR
C     EACH PROFESSOR.
      DIMENSION PROF(50),V1K(50),V2K(50),V3K(50)
      INTEGER PROF
      WRITE (6,7)
    7 FORMAT ('1',11X,'PROF',7X,'V1K',7X,'V2K',7X,'V3K',5X,
     *4X,'AD',8X,'CD'///)
C
C   READ NO OF PROFS TO BE READ
C
      READ (5,3) NOPROF
    3 FORMAT (I5)
      IF (NOPROF.GT.50) GO TO 10
C
C   READ INFORMATION FOR EACH PROF
C
      DO 1 I=1,NOPROF
    1 READ (5,2) PROF(I),V1K(I),V2K(I),V3K(I)
    2 FORMAT (I10,3F10.2)
      DO 9 I = 1,NOPROF
      ICDOM = 1
      IADOM = 1
C
C   TESTS FOR COMPLETE DOMINANCE
C
      DO 5 J = 1,NOPROF
      IF (I.EQ.J) GO TO 5
      Y = (V2K(J)-V2K(I) + V1K(J) - V1K(I))/(V3K(I)-V3K(J))
      IF (V3K(I).EQ.V3K(J)) GO TO 11
      IF((V3K(I).LT.V3K(J).AND.V1K(I).LT.V1K(J).AND.Y.LT.0.0).OR.
     *(V3K(I).GT.V3K(J).AND.V1K(I).LT.V1K(J).AND.Y.GT.1.0)) GO TO 4
      GO TO 5
   11 Y = (V2K(J)-V2K(I))/(V1K(I)-V1K(J))
      IF(V1K(J).LT.V1K(I).AND.Y.LT.1.0) GO TO 4
      IF(V1K(J).EQ.V1K(I).AND.V2K(J).GT.V2K(I)) GO TO 4
    5 CONTINUE
      ICDOM = 0
C
```

```
C
    4 WRITE(6,537) I,J,Y
  537 FORMAT(9X,I5,5X,I5,F10.6)
C
C    TESTS FOR ABSOLUTE DOMINANCE
C
      DO 8 J=1,NOPROF
      IF (I.EQ.J) GO TO 8
      IF (V1K(J).GT.V1K(I).AND.V2K(J).GT.V2K(I).AND.
     *V3K(J).GT.V3K(I)) GO TO 9
    8 CONTINUE
      IADOM=0
    9 WRITE (6,6) PROF(I), V1K(I),V2K(I),V3K(I),IADOM,ICDOM
    6 FORMAT (5X,I10,2X,3F10.3,2I10)
   10 STOP
      END
$GO
```

PROGRAM 5 PAIRED COMPARISONS

```
//  EXEC  FORTCLG,PARM.FORT='LIST,SOURCE,NODECK,MAP',                    *
//    REGION.GO=175K,TIME.GO=2
//FORT.SYSIN DD *
C   THIS PROGRAM COMPARES THE SCORES OF THE ITH PROFESSOR AGAINST
C   THAT OF THE JTH PROFESSOR WITH THE CONSTRAINT THAT EACH OF
C   THESE PROFESSORS IS KNOWN BY A GIVEN VOTER.
C
C
      DIMENSION NK(20),ALPHA(20,20),BETA(20,20),SCORE(20,20),FILLER(4)
      DIMENSION FRACT(20,20,3),XIK(20,20,3)
      INTEGER BALLOT (20,240),VOTE(20,240),PROF(20),B,P,V
      INTEGER ROF(20)
      INTEGER ONE,TWO,THREE
C
C   N IS THE NUMBER OF PROFESSORS TO BE COMPARED.
C   NN IS THE MAXIMUM VALUE OF NK AMONG THE N PROFESSORS.
C   NNN IS THE NUMBER OF PLACE VOTES.
C
      READ (5,1) N,NN,NNN
    1 FORMAT (3I5)
      WRITE (6,61) N,NN,NNN
   61 FORMAT (10X,3I5)
C
C   READ WEIGHTS FOR VOTES.
C
      READ (5,51) ONE,TWO,THREE
   51 FORMAT (3I5)
      WRITE (6,51) ONE,TWO,THREE
C
C   READ PROFESSOR NUMBER IN ASCENDING ORDER.
C
      READ (5,101) (ROF(I),I=1,N)
  101 FORMAT (I5)
      WRITE (6,101) (ROF(I),I=1,N)
C
C   READ NK AND PROFESSOR IN DESIRED ORDER OF OUTPUT (USUALLY ORDERED
C   BY DESCENDING SCORE).
C
      DO 2 I=1,N
      READ (5,3) NK(I),PROF(I)
    3 FORMAT (2I5)
    2 CONTINUE
      WRITE (6,41) (PROF(I), I=1,N)
C
C   ZERO MATRICES
```

```
C
      DO 13 I=1,N
      DO 13 J=1,N
      ALPHA(I,J)=0.0
      BETA(I,J)=0.0
      SCORE(I,J)=0.0
      DO 13 K=1,NNN
      XIK(I,J,K)=0.0
   13 FRACT(I,J,K)=0.0
      DO 15 I=1,N
      DO 15 J=1,NN
      BALLOT (I,J)=0
   15 VOTE (I,J)=0
      K=0
C
C    READ PROF FILE AND SEARCH PROFESSOR NUMBER FIELD.
C
    4 K=K+1
    6 READ (8,5) B,P,V,FILLER(1),FILLER(2),FILLER(3),FILLER(4)
    5 FORMAT (I4,I3,I1,3A4,A2)
      IF (P.NE.ROF(K)) GO TO 6
      DO 100 I=1,N
      IF (ROF(K).NE.PROF(I)) GO TO 100
      BALLOT(I,1)=B
      VOTE (I,1)=V
      M=NK(I)
C
C    READ REMAINING RECORDS FOR A GIVEN PROFESSOR.
C
      DO 7 J=2,M
      READ (8,5) BALLOT(I,J),PROF(I),VOTE(I,J),
     1FILLER(1),FILLER(2),FILLER(3),FILLER(4)
    7 CONTINUE
  100 CONTINUE
      IF (K.NE.N) GO TO 4
C
C    APPLY WEIGHT FACTORS TO EACH VOTE.
C
      DO 52 I=1,N
      DO 52 J=1,NN
      IF (VOTE(I,J).EQ.1) GO TO 53
      IF (VOTE(I,J).EQ.2) GO TO 54
      IF (VOTE(I,J).EQ.3) GO TO 55
      GO TO 52
   53 VOTE(I,J)=THREE
      GO TO 52
   54 VOTE(I,J)=TWO
      GO TO 52
```

```
   55 VOTE(I,J)=ONE
   52 CONTINUE
      L=N-1
C
C     COMPUTE COMPARISON NK, ZK, AND XIK FOR EACH PROFESSOR.
C
      DO 10 I=1,L
      K=I+1
      DO 10 II=K,N
      M=NK(I)
      MM=NK(II)
      DO 12 J=1,M
      DO 12 JJ=1,MM
      IF (BALLOT(I,J).NE.BALLOT(II,JJ)) GO TO 12
      WRITE (6,75) BALLOT(I,J)
   75 FORMAT (10X,I4)
      ALPHA(I,II)=ALPHA(I,II)+1
      ALPHA(II,I)=ALPHA(II,I)+1
      BETA(I,II)=VOTE(I,J)+BETA(I,II)
      BETA(II,I)=VOTE(II,JJ)+BETA(II,I)
      IF (VOTE(I,J).EQ.ONE) GO TO 62
      IF (VOTE(I,J).EQ.TWO) GO TO 63
      IF (VOTE(I,J).EQ.THREE) GO TO 64
      GO TO 65
   62 XIK(I,II,1)=XIK(I,II,1)+1
      GO TO 65
   63 XIK(I,II,2)=XIK(I,II,2)+1
      GO TO 65
   64 XIK(I,II,3)=XIK(I,II,3)+1
   65 IF (VOTE(II,JJ).EQ.ONE) GO TO 66
      IF (VOTE(II,JJ).EQ.TWO) GO TO 67
      IF (VOTE(II,JJ).EQ.THREE) GO TO 68
      GO TO 69
   66 XIK(II,I,1)=XIK(II,I,1)+1
      GO TO 69
   67 XIK(II,I,2)=XIK(II,I,2)+1
      GO TO 69
   68 XIK(II,I,3)=XIK(II,I,3)+1
   69 CONTINUE
   12 CONTINUE
   10 CONTINUE
C
C     COMPUTE COMPARISON FRACTIONS OF PLACE VOTES.
C
      DO 70 I=1,N
      DO 70 II=1,N
      IF (ALPHA(I,II).EQ.0.0) GO TO 70
      DO 74 K=1,NNN
```

```
   74 FRACT(I,II,K)=XIK(I,II,K)/ALPHA(I,II)
   70 CONTINUE
C
C    COMPUTE COMPARISON SCORE.
C
      DO 20 I=1,N
      DO 20 II=1,N
      IF (ALPHA(I,II).EQ.0.0) GO TO 20
      SCORE (I,II)=BETA(I,II)/ALPHA(I,II)
   20 CONTINUE
C
C    WRITE RESULTS.
C
      DO 50 I=1,N
      WRITE (6,30)
   30 FORMAT ('1',50X,'PAIRED COMPARISONS OF FACULTY MEMBERS')
      WRITE (6,40)
   40 FORMAT (////10X,'PROF',6X,'NK',8X,'BALLOT',4X,'VOTE',4X)
      WRITE (6,41) NK(I)
   41 FORMAT (/20X,I3)
      M=NK(I)
      DO 50 J=1,M
      WRITE (6,42) BALLOT(I,J),VOTE(I,J)
   42 FORMAT (30X,I4,6X,I1)
   50 CONTINUE
      WRITE (6,34)
   34 FORMAT ('1',57X,'N MATRIX'//)
      WRITE (6,35) ((ALPHA(I,II),II=1,N),I=1,N)
   35 FORMAT (/20(2X,F4.0))
      WRITE (6,36)
   36 FORMAT ('1',57X,'Z MATRIX'//)
      WRITE (6,35) ((BETA(I,II),II=1,N),I=1,N)
      WRITE (6,37)
   37 FORMAT ('1',55X,'SCORE MATRIX'//)
      WRITE (6,38) ((SCORE(I,II),II=1,N),I=1,N)
   38 FORMAT (/20(2X,F4.2))
      WRITE (6,71)
   71 FORMAT ('1',53X,'FRACTION MATRIX'//)
      DO 73 I=1,N
      DO 73 II=1,N
      WRITE (6,72) I,II,(FRACT(I,II,K),K=1,NNN)
   72 FORMAT (//10X,I2,'VS.',I2/10X,3(F10.5,5X))
   73 CONTINUE
      STOP
      END

//GO.FT06F001 DD SYSOUT=A,SPACE=(CYL,(8,3))
//GO.FT08F001   DD  DSNAME=PRO,UNIT=2400,VOL=SER=NPS262,LABEL=(,NL),    *
```

```
//    DISP=(OLD,KEEP),DCB=(RECFM=FB,LRECL=22,BLKSIZE=1100)
//GC.SYSIN DD *
```

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13. ABSTRACT

The procedure and data of the Second Annual Award for Excellencecellence in Teaching are discussed and studied. Basic statistics of balloting are presented and increased participation is noted. The techniques of data reduction are described. Some special studies are made concerning (i) score data has distribution of mixed exponential type (ii) the effect on the score of whether or not an instructor teaches during the quarter of the balloting (iii) concordance determination with last year's ranking of instructors. Recommendations for modifying future procedural items are made.

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